TISA working group report

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CERES Science Team Meeting, NASA-Langley, May 5-7, 2015

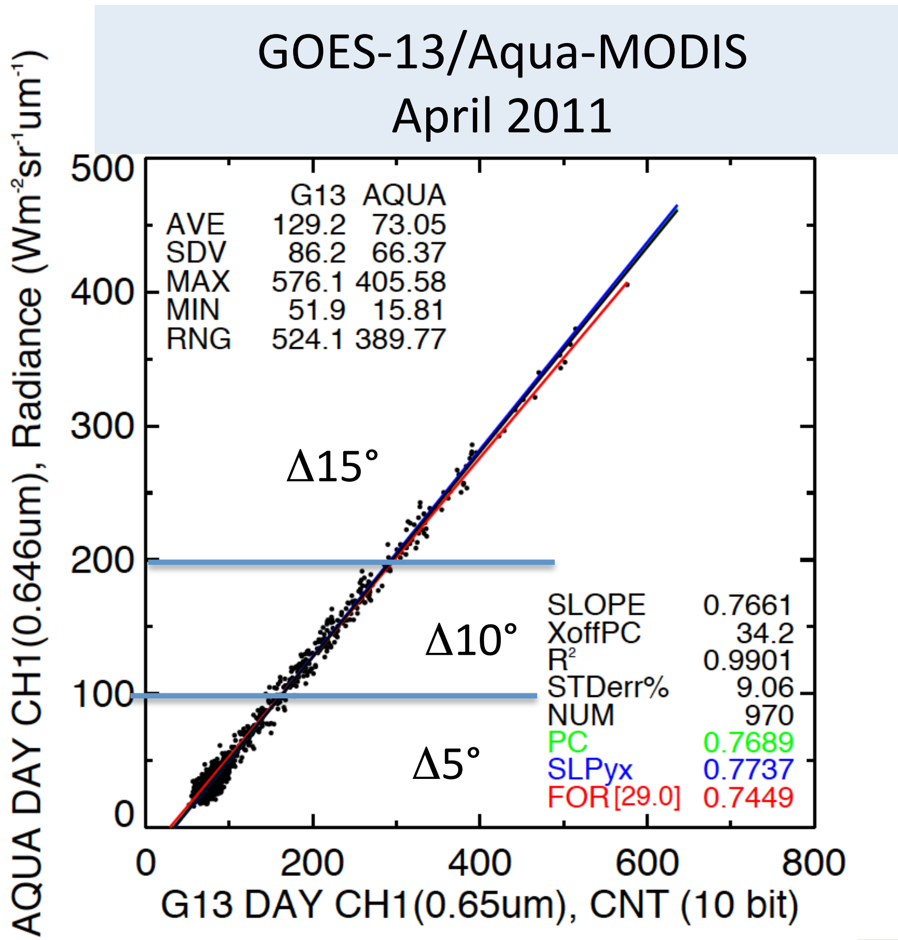
Outline

- Migration to GEO/MODIS to GEO/VIIRS inter-calibration
- GEO spurious image detection (QC) and Edition 4 processing
- CldTypHist product development
- Future TISA efforts

GEO Calibration

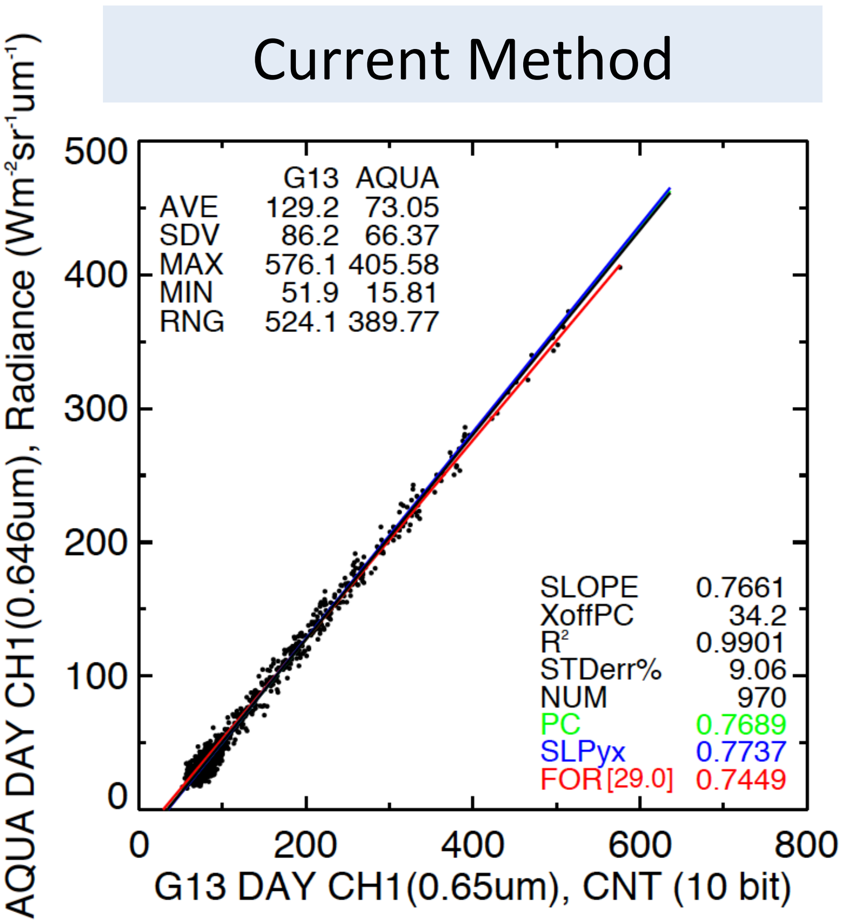
- Improvements in GEO/LEO ray-matching
  - Graduated angle threshold gridded ray-matching
  - SCIAMACHY based Spectral Band Adjustment Factor (SBAF) validation
- NPP VIIRS Land-PEATE I1 band stability
  - DCC, desert sites, SNO
- Compute MODIS relative calibration difference
- If the VIIRS/GEO and MODIS/GEO calibration gains are the same, then we have successfully migrated from MODIS to VIIRS
  - Apply MODIS/VIIRS calibration adjustment factor and spectral adjustments

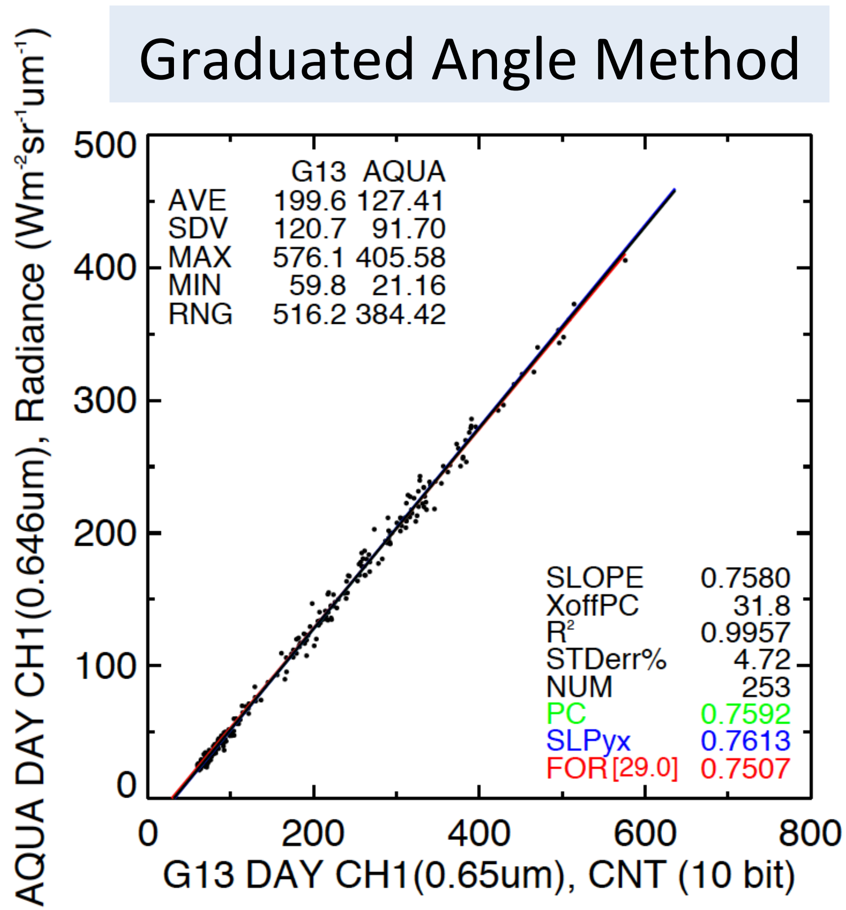
Graduated Angle threshold Method, Gridded Ray-Matching



- Match coincident in time, angle and location, 0.5° by 0.5° lat/lon gridded GEO/ MODIS radiances, apply a spatial visible sigma <0.7% threshold
- Apply VZA and AZA difference threshold as described above
- Bright scenes are sparse, more lambertian, needs the least spectral band adjustment and increases the dynamic range to decrease the standard error of the fit

GOES-13/Aqua-MODIS gridded ray-matching, April 2011





- The linear and space count regression slopes are more consistent using GAM
- The regression predicted space count of 31.8 is much closer to 29
- Clear-sky angle matching more critical then bright clouds

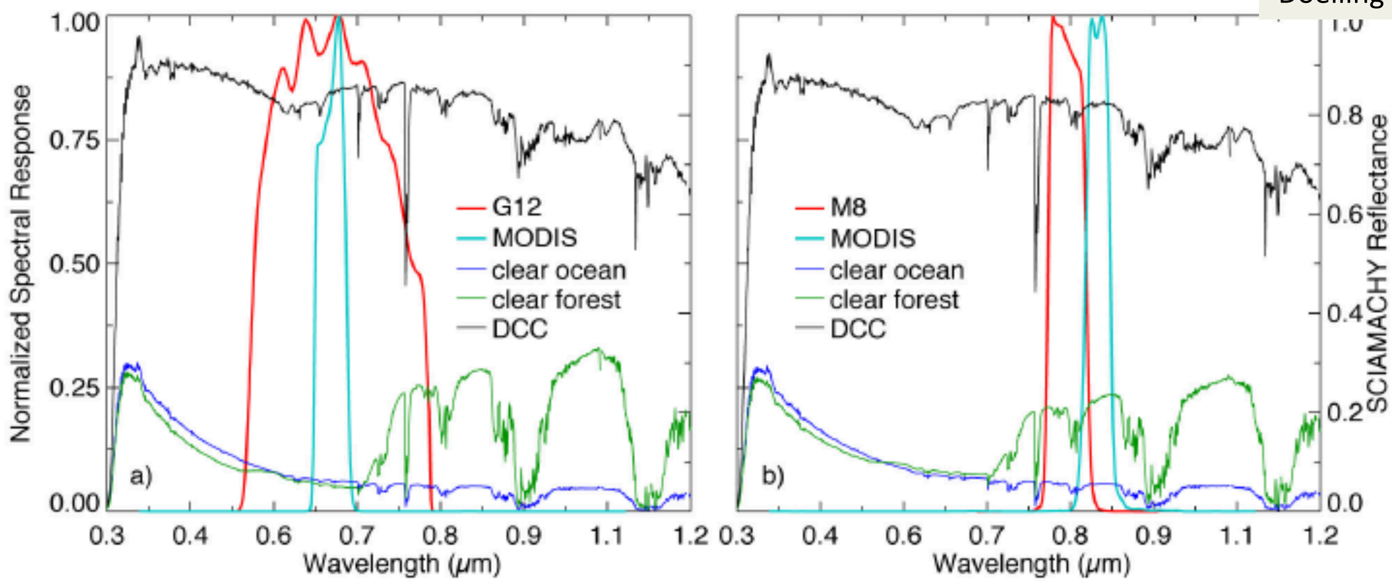
Graduated Angle threshold Method, Gridded Ray-Matching

	Force-linear		Space count			Monthly Sigma	
GEO	No GAM	GAM	No GAM	GAM	observed	No GAM	GAM
GOES-13	2.4	0.7	32.6	30.4	29	8.0	5.0
GOES-15	0.8	0.3	30.3	30.1	29	7.6	5.4
Met-7	0.5	0.2	4.5	4.9	4.9	7.0	5.3
Met-10	0.7	0.4	52.8	52.2	51	4.9	3.3
MTSAT-2	0.1	0.1	1.9	2.1	2	8.0	6.0

- The GAM linear and force fits are more consistent
- The GAM space count is close to the observed
- The monthly scatter has also been significantly reduced

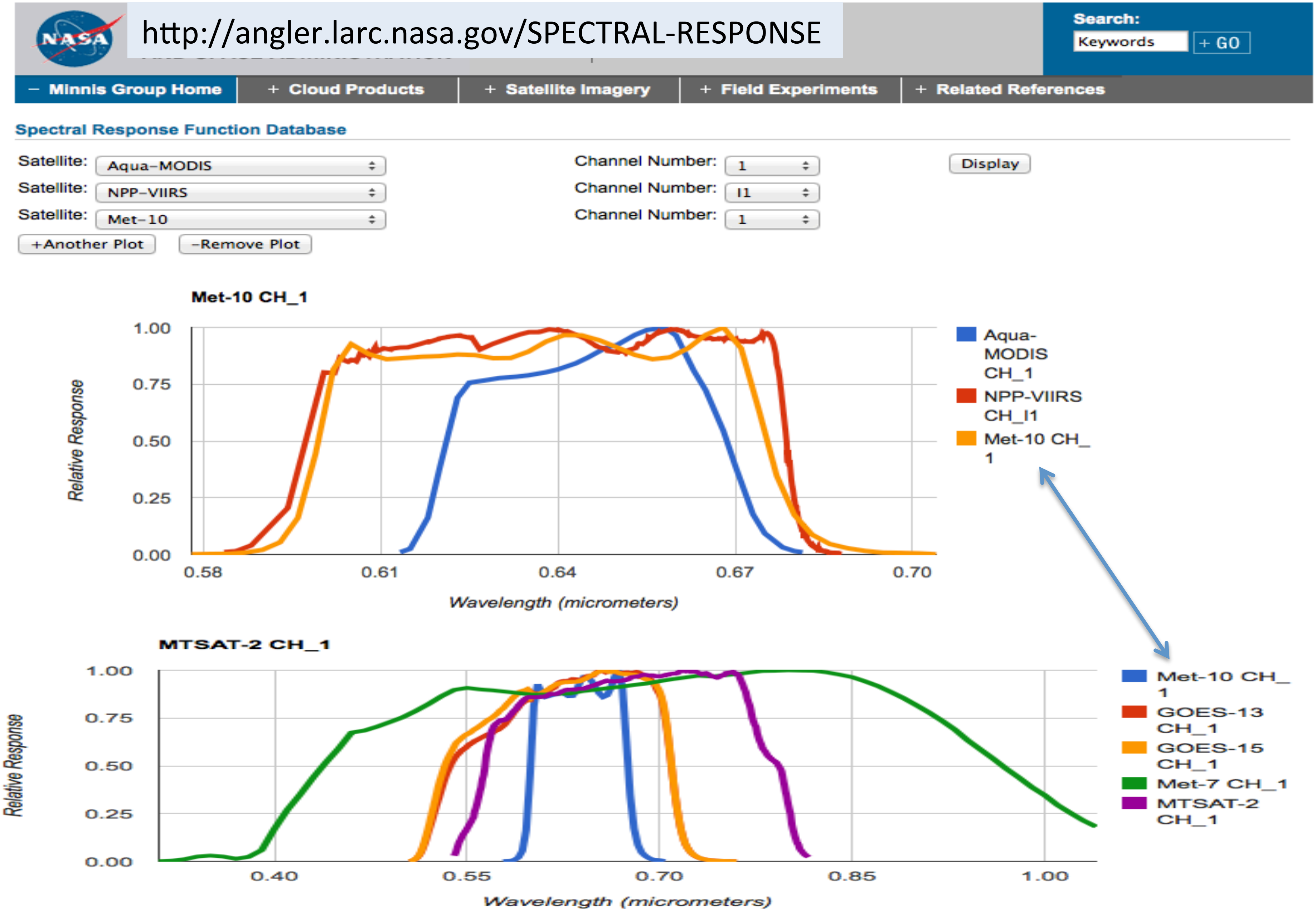
MODIS or VIIRS to GEO spectral band adjustment factor (SBAF)

Doelling et al 2010



- Use SCIAMACHY hyper-spectral radiances to convolve GEO and MODIS or VIIRS pseudo radiances to compute SBAF over various calibration targets
- GEO Edition 3 did not adjust for spectral band differences to facilitate GEO 2-channel cloud code
  - Applied solar constant ratio
- Developed Spectral Response function, Band Solar Constant, and SBAF public tools

Spectral Response Function (SRF) comparison tool



Solar Constant Comparison Tool

http://angler.larc.nasa.gov/SOLAR-CONSTANT-COMPARISONS

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– Minnis Group Home | + Cloud Products | + Satellite Imagery | + Field Experiments | + Related References

- Solar constant ratio must derived from the solar spectra

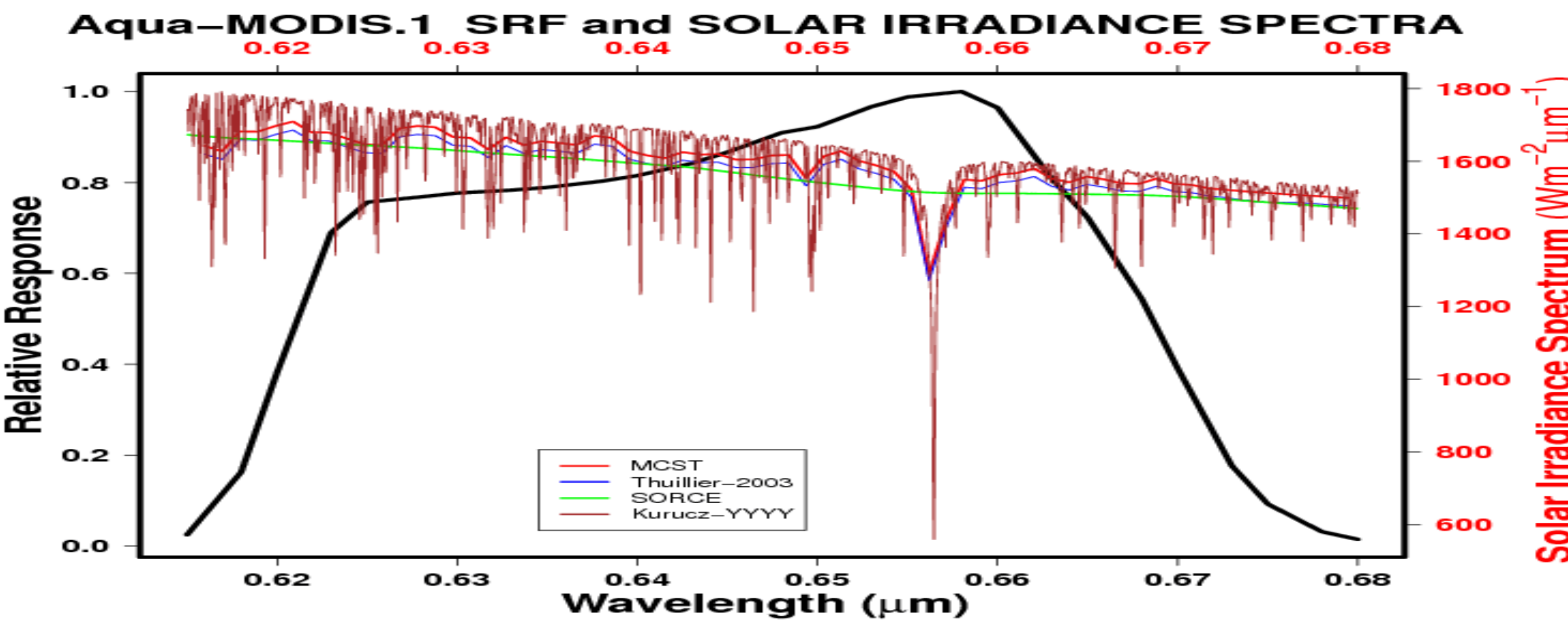
Solar Constant Comparison

Bnad Solar Constant Comparisons

SRF	Solar Spectra (1)	Solar Spectra (2)	Solar Spectra (3)	Solar Spectra (4)
ATS-2	Thuillier-2003	None	None	None
Aqua-MODIS	SORCE	Thuillier-2003	Thuillier-2003	Thuillier-2003
COMS-1	MCST	SORCE	SORCE	SORCE
DSCOVR-EPIC	Wherli-YYYY	MCST	MCST	MCST
EO-1-ALI	Kurucz-YYYY	Wherli-YYYY	Wherli-YYYY	Wherli-YYYY
FY-2C	Thekaekara	Kurucz-YYYY	Kurucz-YYYY	Kurucz-YYYY
FY-2D		Thekaekara	Thekaekara	Thekaekara
FY-2E				

Central Wavelength: 0.65 Micron (1) Plot

Plot of /prod/website/temp/SOLAR_CONST/Aqua-MODIS.1_web-invoke-24859.gif below



Spectral Response File: Aqua-MODIS.1						
Solar Spectrum Reference	Band Center (micron)	Eqv. Width (microns)	Flux (W m-2)	IRRADIANCE (W m-2 um-1)	RADIANCE (W m-2 um-1 sr-1)	Solar Constant (Mean Sun-Earth Distance)
MCST (MODIS)	0.64586	0.04248	67.96754	1600.12512	509.33563	1380.4011
Thuillier	0.64586	0.04248	67.02752	1577.99475	502.29132	1315.7004
SORCE	0.64586	0.04249	66.59808	1567.53516	498.96191	1309.6921
Kurucz	0.64586	0.04249	68.07352	1602.25769	510.01443	1373.0055

Spectral Band Adjustment Factor (SBAF) Tool

http://angler.larc.nasa.gov/SBAF

+ NASA Portal
+ Preferences

Search: Keywords + GO

− Minnis Group Home | + Cloud Products | + Satellite Imagery | + Field Experiments | + Related References

Spectral Band Adjustment Factor

Spectral Band Adjustment Factor (SBAF) calculator based on SCIAMACHY visible hyper-spectral data.

Reference: Scarino, B., D. R. Doelling, P. Minnis, A. Gopalan, T. Chee, R. Bhatt, C. Lukashin, and C. O. Haney, "A Web-based Tool for Calculating Spectral Band Difference Adjustment Factors Derived from SCIAMACHY Hyper-spectral Data," Submitted to IEEE Trans. Geosci. Remote Sens., 2014.

Comments or feedback? Contact Ben Scarino

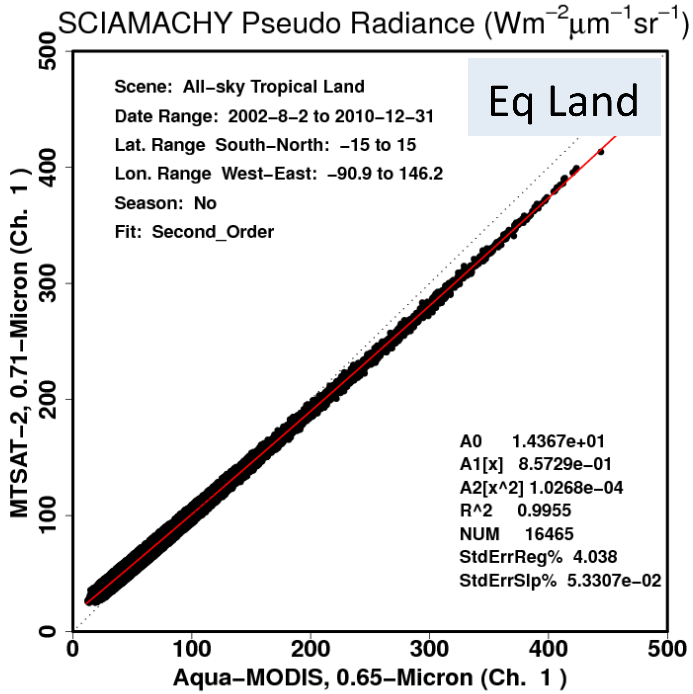
For this tool, SCIAMACHY data are limited to the continuous spectral range of Channels 1-6, or 0.24 - 1.75µm.

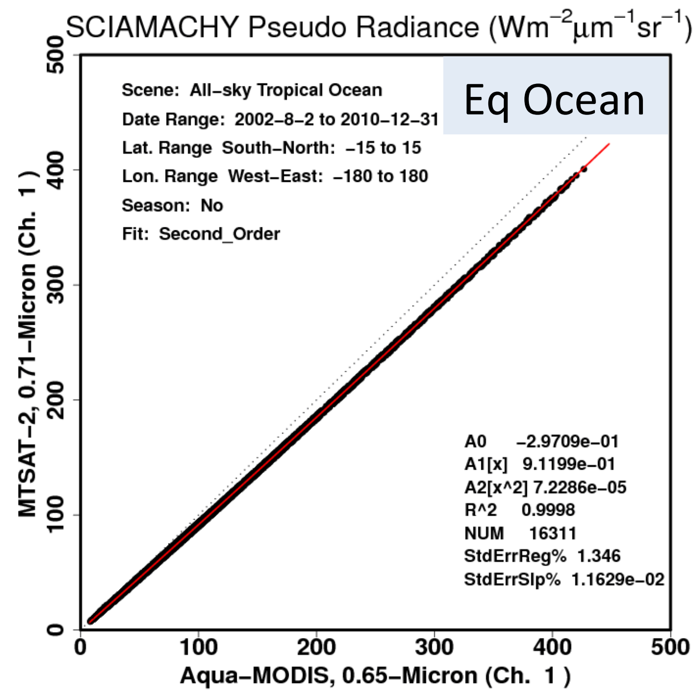
Imager-equivalent "pseudo" radiance values are in units of $Wm^{-2}\ \mu m^{-1}\ sr^{-1}$. Pseudo scaled radiance, or reflectance, is a product of the SRF-convolved radiance divided by the SRF-convolved SCIAMACHY solar constant and a factor of π.

Earth Spectra (SCIAMACHY)	Reference (X-axis) SRF	Target (Y-axis) SRF	Units	Regression
Arabia 1	ATS-2	ATS-2	Pseudo Radiance	Force Fit
Arabia 2	Aqua-MODIS	Aqua-MODIS	Pseudo Scaled Radiance	Linear
Badain Jaran Desert	COMS-1	COMS-1		2nd Order
Dome C	DSCOVR-EPIC	DSCOVR-EPIC		3rd Order
Greenland Central	EO-1-ALI	EO-1-ALI		Advanced
Greenland South	FY-2C	FY-2C		
Libya 1	FY-2D	FY-2D		
Libya 4	FY-2E	FY-2E		
Niger 1	GMS-1	GMS-1		
Sonoran Desert	GMS-2	GMS-2		
All-sky Tropical Land	GMS-3	GMS-3		
All-sky Tropical Ocean	GMS-4	GMS-4		
Clear-sky Tropical Ocean	GMS-5	GMS-5		
Approximate DCC	GOES-10	GOES-10		
Precise DCC	Central Wavelength:	Central Wavelength:		
North Pole				

Plot

Aqua-MODIS/MTSAT-2 SBAFs





Scene, Aqua/MTSAT-2	slope	Departure from SC %
Solar Constant	0.941	0.0
DCC	0.940	-0.1
Badain Desert Summer	0.933	-0.9
Badain Desert Winter	0.939	-0.2
Clear-sky Ocean	0.904	-3.9

- All GEO/MODIS inter-calibration performed over equatorial domain
- SBAF is based on a quadratic fit to take into account changes in scene type as function of radiance
- Using solar constant ratio will introduce biases

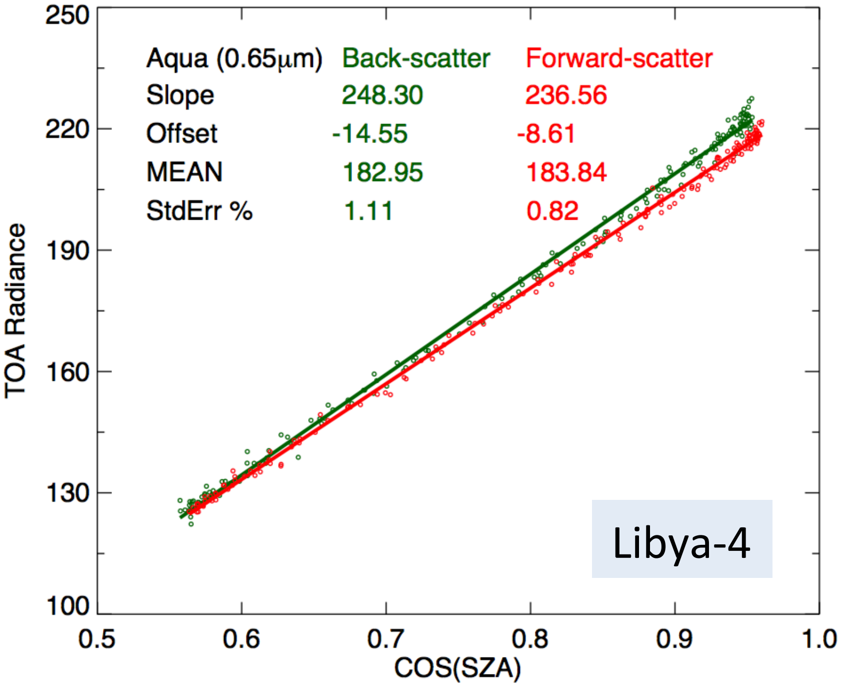
Improved consistency when applying SBAF compared to SC ratio

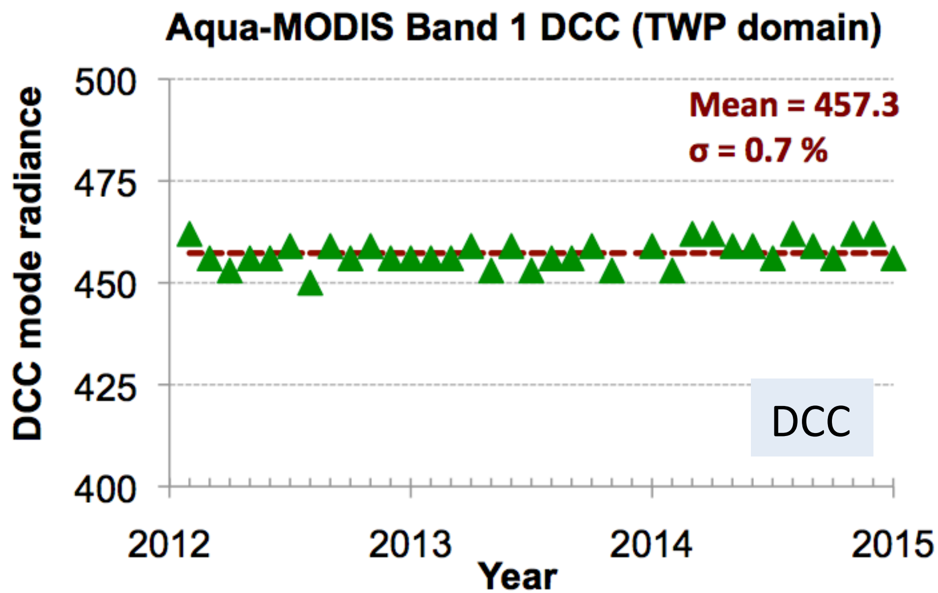
Aqua	Force-linear		Space count		
GEO	SC	SBAF	SC	SBAF	observed
GOES-13	-1.8	-0.7	33.1	30.4	29
GOES-15	-1.7	-0.3	33.2	30.1	29
Met-7	-1.5	-0.2	6.0	4.9	4.9
Met-10	-0.8	-0.4	53.8	52.2	51
MTSAT-2	+0.9	+0.1	-2.4	2.1	2

VIIRS	Force-linear		Space count		
GEO	SC	SBAF	SC	SBAF	observed
GOES-13	-1.2	-0.6	31.4	29.7	29
GOES-15	-1.3	-0.6	31.9	29.9	29
Met-7	-0.9	+0.1	5.6	4.7	4.9
Met-10	-0.1	-0.1	51.3	51.3	51
MTSAT-2	+1.5	0.0	-5.7	0.5	2

- Linear regression of GEO and MODIS radiance pairs are closer to the observed space count
- The linear regression and regression through space count (force fit) are more consistent
- VIIRS seems to be higher quality imager than MODIS, since it predicts the GEO space counts better than MODIS

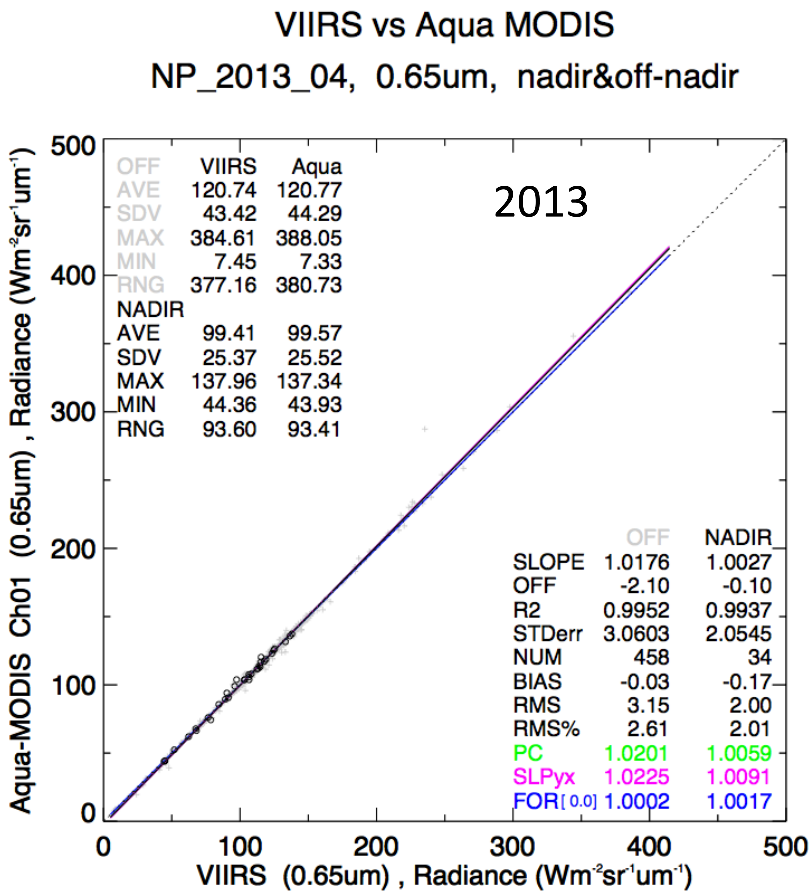
Reference desert and DCC calibration models

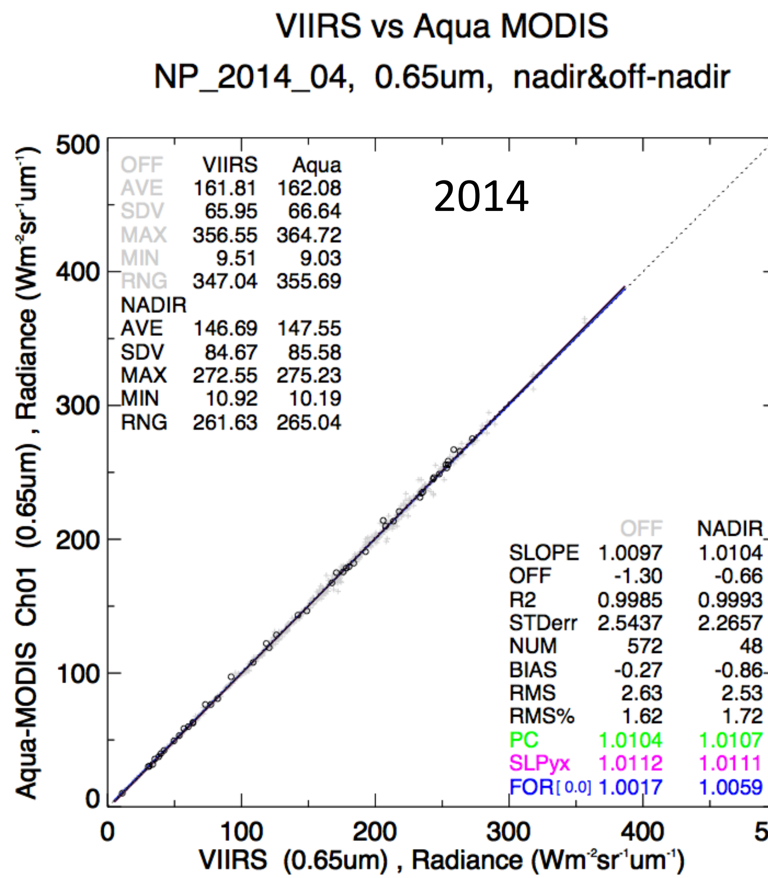




- Libya-4 desert and TWP DCC are referenced to Aqua-MODIS Band 1 C6 calibration using multiple years of observations.
- Libya-4 calibration model is scattering direction-dependent and derived from near-nadir observations only (VZA<10°) during 2002-2013.
- Observed Aqua-MODIS Band 1 monthly DCC mode radiances are averaged during the VIIRS time frame (2012-2014) to estimate the mean reference DCC response for the TWP domain.

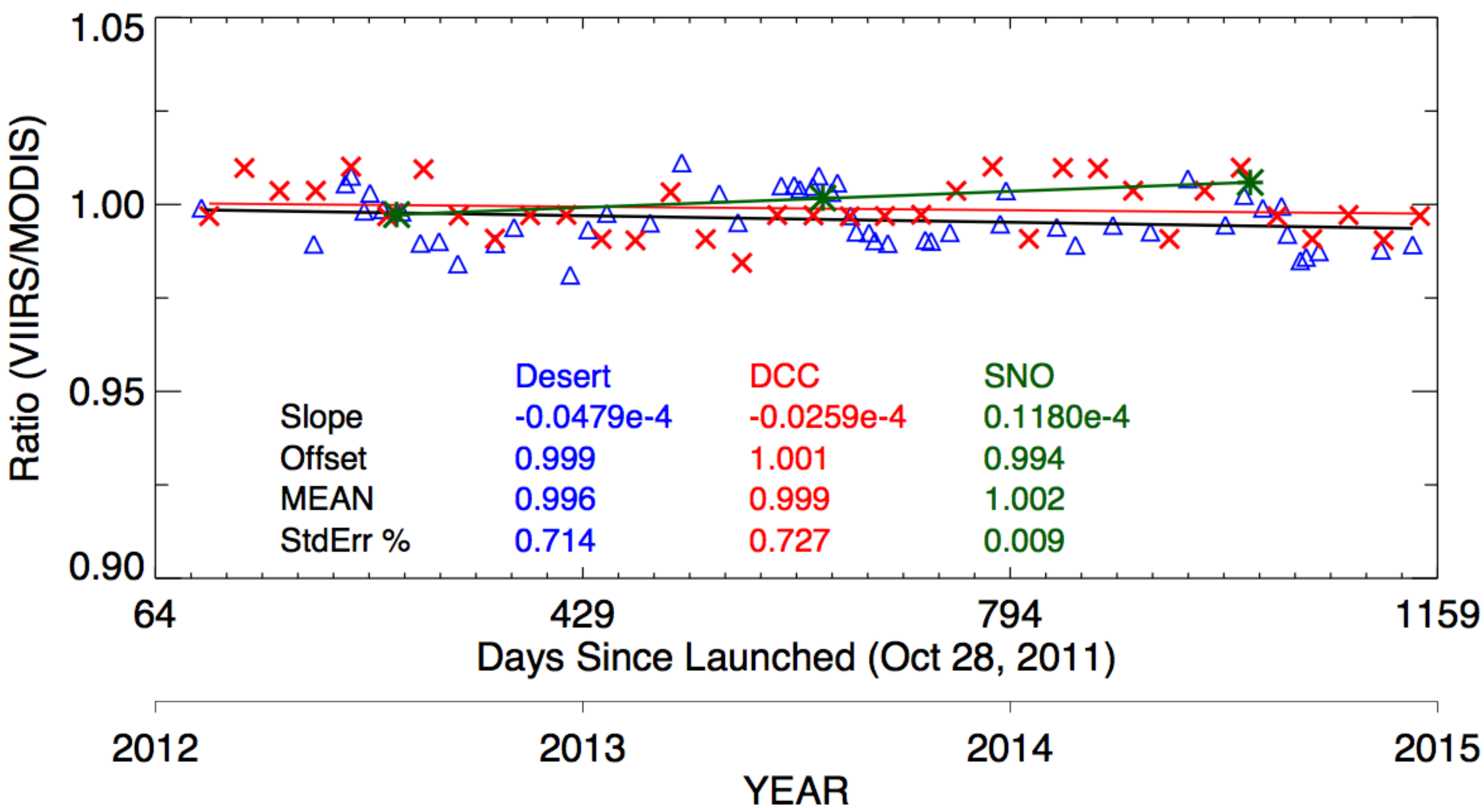
Aqua-MODIS and NPP-VIIRS Simultaneous Nadir Observations (SNO)





- Aqua and SNPP visible SNOs are mostly near the north pole under high SZA conditions during the summer
- Off-nadir points have matching VZA and increase the sampling and dynamic range and nearly matching AZA, since Aqua and SNPP are in the sun synch orbit

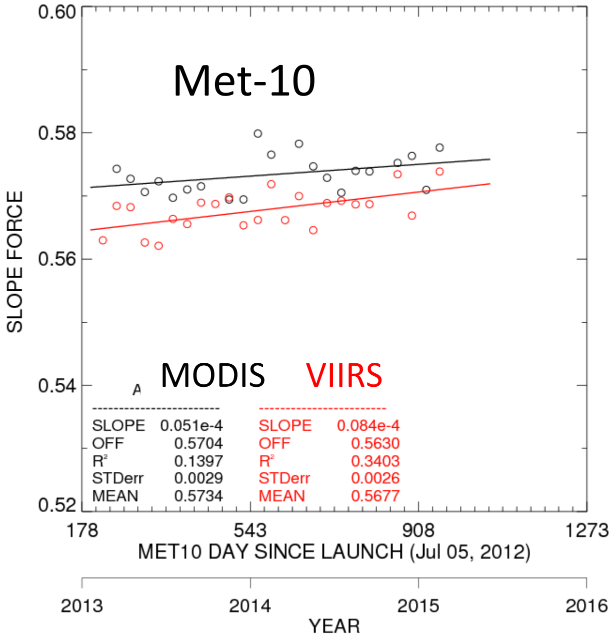
VIIRS I1 band is stable over 3-years

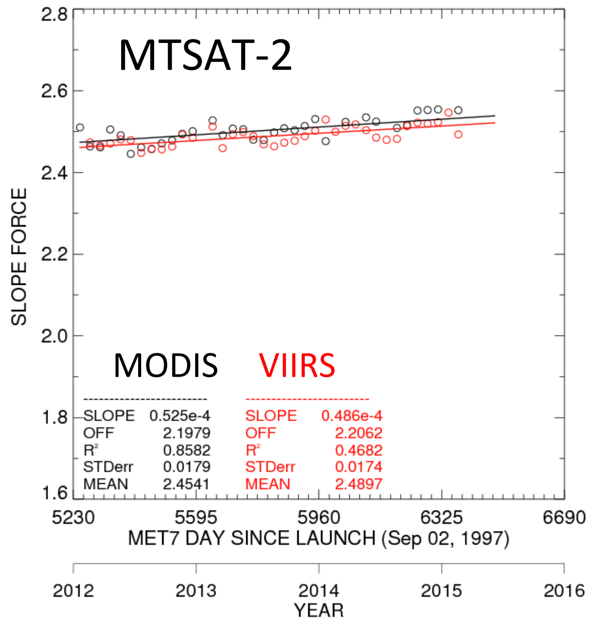


- VIIRS I1 measurements over Libya-4 and TWP DCC domain predicted with Aqua-MODIS models and spectral adjustments
- VIIRS I1 and Aqua-MODIS Band 1 calibrations are found consistent within 0.5% using DCC, desert, and SNO approaches.

GEO/VIIRS and GEO/MODIS

Inter-calibrate GEO/VIIRS and GEO/MODIS over the equatorial ocean domain using the same code, Should provide the same gain if everything is working





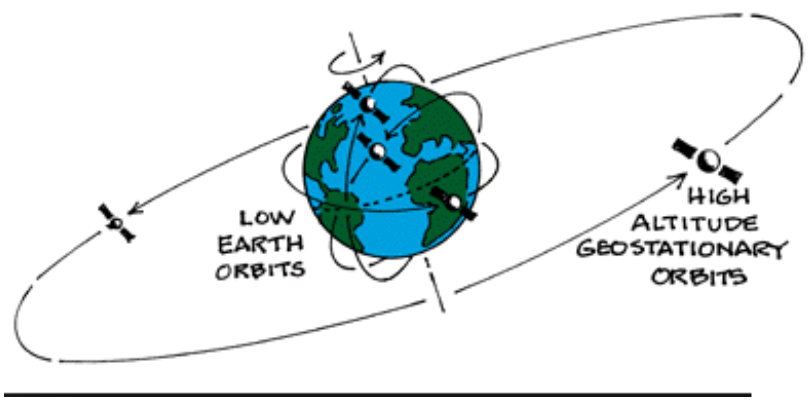
GEO (%)	Bias V-A	Aqua σ	VIIRS σ
Met-10	-1.0	0.5	0.5
GOES-15	-0.7	0.7	0.9
GOES-13	-1.3	0.8	0.6
Met-7	-1.6	0.7	0.7
MTSAT-2	-0.8	1.0	0.9

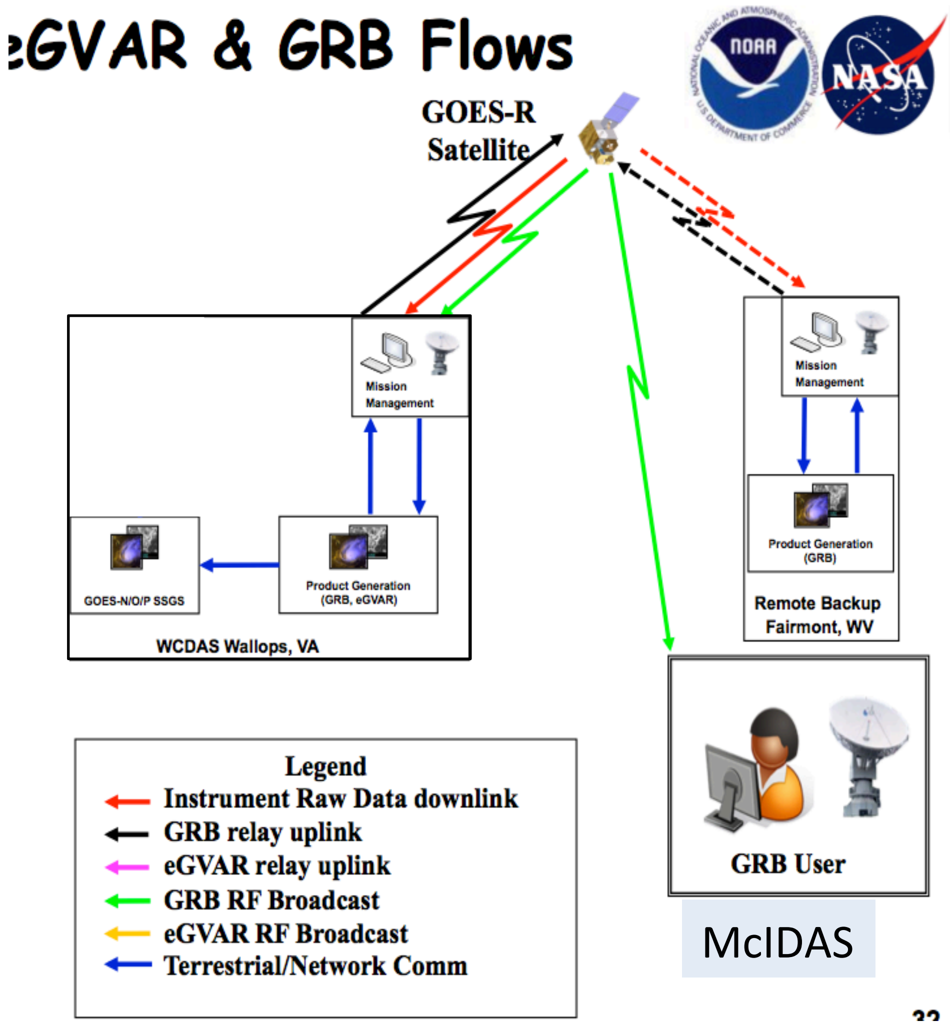
- Still investigating why there is a !% difference between GEO/VIIRS and GEO/MODIS
  - Looking through the code for artifacts
  - Possible Aqua-MODIS degradation past 2011, looking at Earth invariant targets
- Aqua-MODIS C6 has a scan angle dependency where off-nadir pixel radiances can be different by 0.5% from nadir. Working closely with the MODIS and VIIRS team
  - SNO, desert are from nadir scans. DCC and GEO/LEO can have VZA up to 40°

GEO spurious data detection

- Edition 3 utilizes 3-hourly 2-channel GEO images
  - GEO spurious data detection performed monthly by human visualization, since 2012
  - 5 GEO * 2 channel * 31 days * 8 hours/day = 2480 images/month need to QC
- Edition 4 utilizes 1-hourly 5-channel GEO
  - 4 for cloud retrievals, and 1 WV for LW NB to BB
  - 5 GEO * 5 channel * 31 days * 24 hours/day = 18600 images/month need to QC, 7.5 times more than Edition 3
- Employ automated GEO spurious image detection mask
  - Visually inspect all images for the month for each GEO in order to optimize automated mask
    - Tune Mask to capture all visually inspected bad images
    - Tune the Mask to have the fewest false positives
  - Categorize bad images for impact on cloud retrieval program
- GEO off-line processing production
  - Only visually inspect images flagged by mask and remove bad sections of images
  - About a 6 months effort, limited by the visualization and cleaning effort

GEO Data Transmission

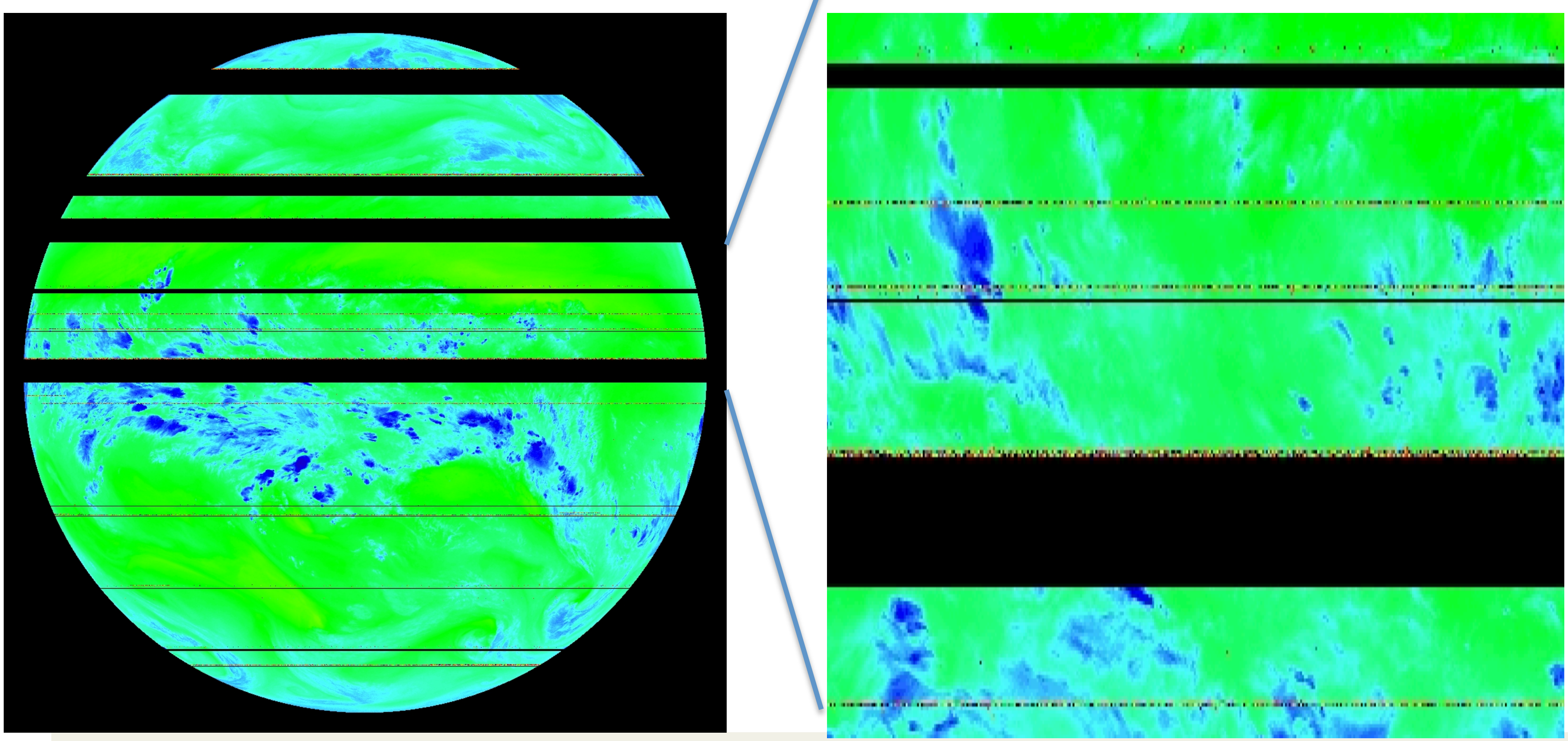




- The GEO Level 1 data is transmitted to Earth be processed (navigation, calibration adjustments), and transmitted back to the satellite as level 1b data, which the McIDAS antenna receives and archives.
- The data is transmitted 3 times through space, potential for spurious signals.
- The GEO has 7x the path length of a LEO.

Spurious Bad scan lines

Met-5, March 21, 2000, 13:00 GMT



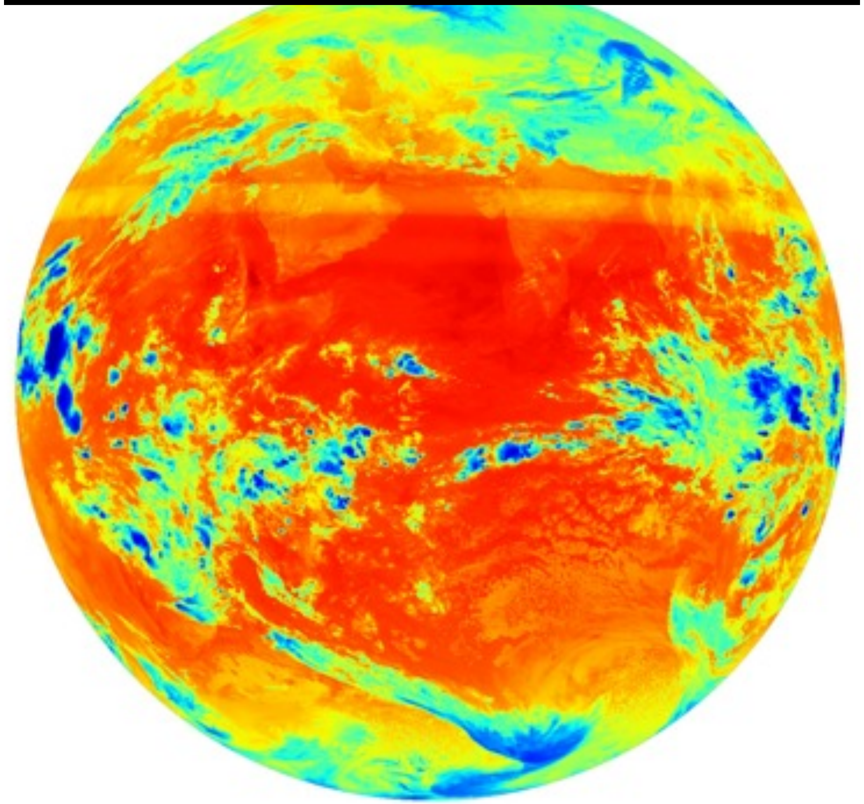
• Mostly scan lines are missing and pixel count values are recorded as 0, rebroadcast level 1b data to satellite and to McIDAS

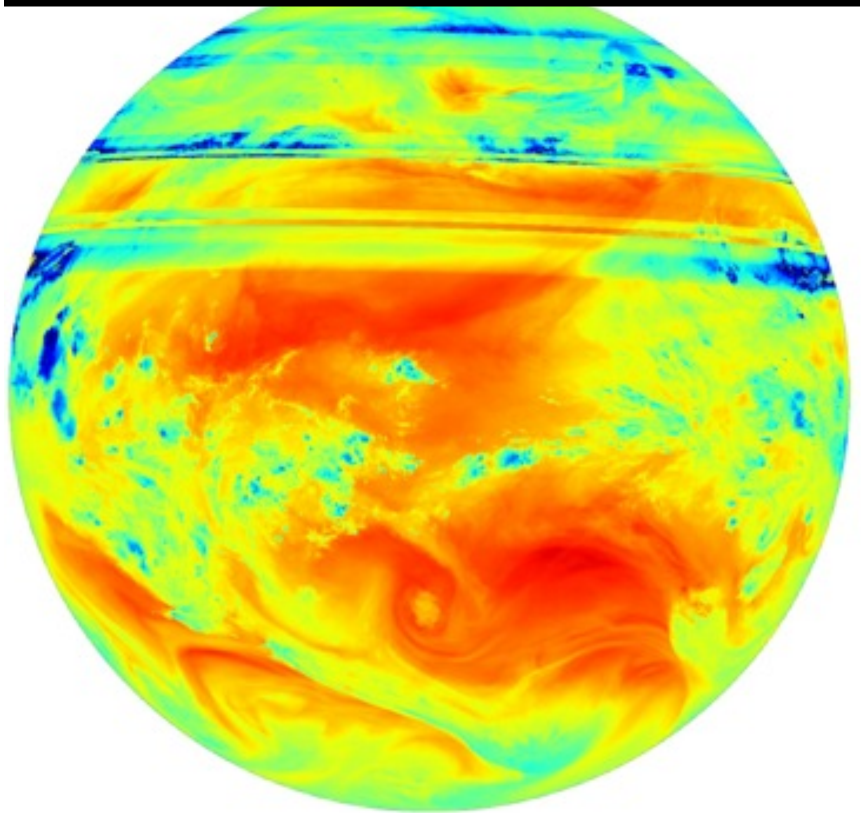
• However, there pixel values that encompass the entire range of values, potentially causing spurious cloud retrievals, initial broadcast of level 1 data

Spurious Banding

Met-5, March 21, 2000, 13:00 GMT

IR	WV

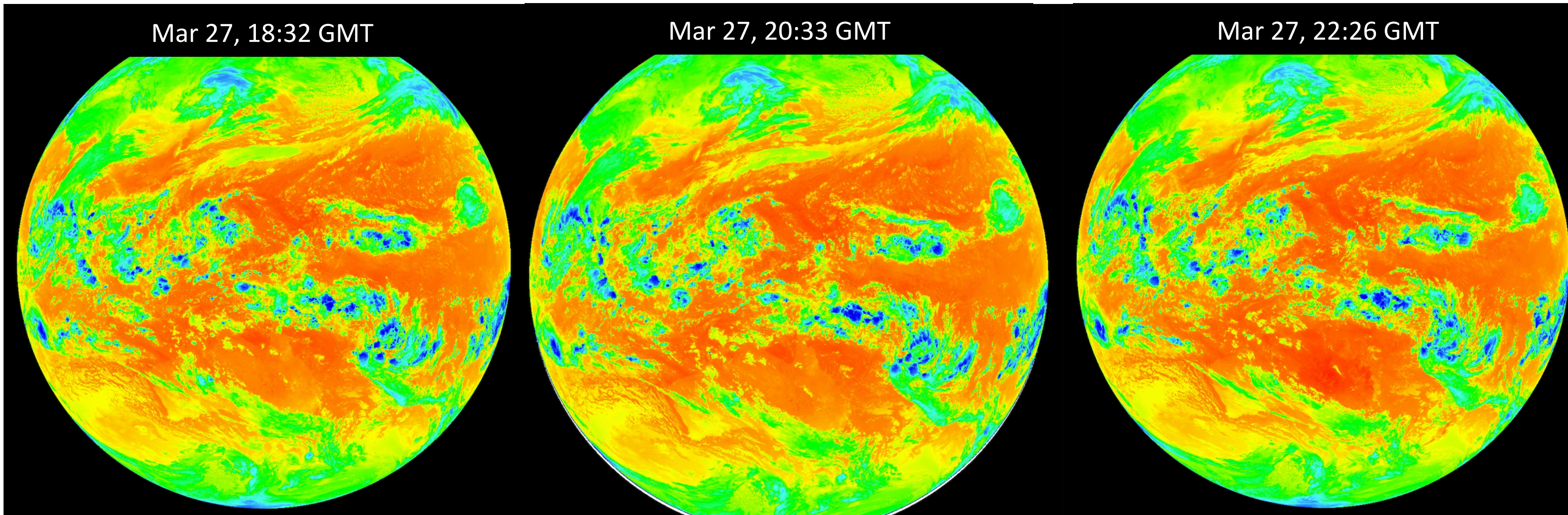


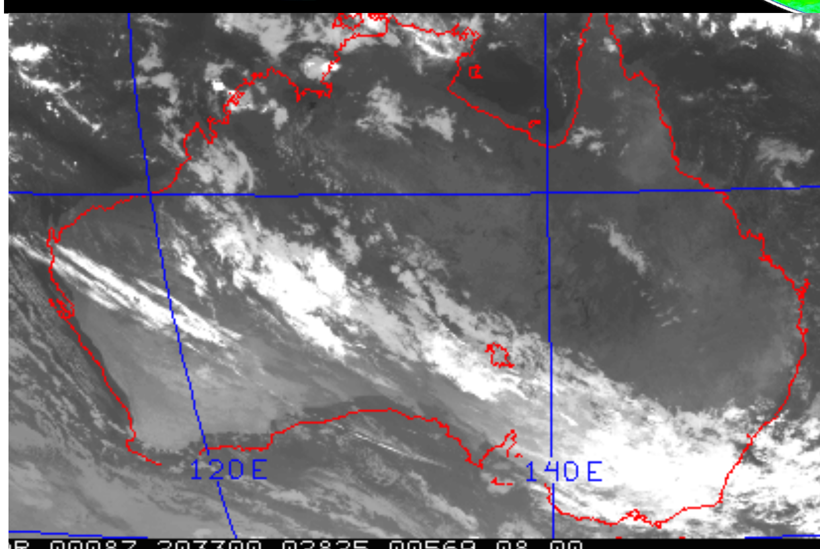


- Met-5 and Met-7 have banding issues, worst cases likes this are now able to be detected in automated program

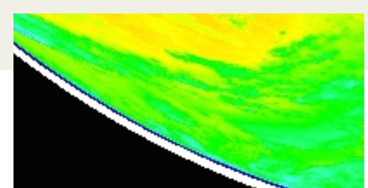
Navigation

GMS-5, 11 µm, March 27, 2000



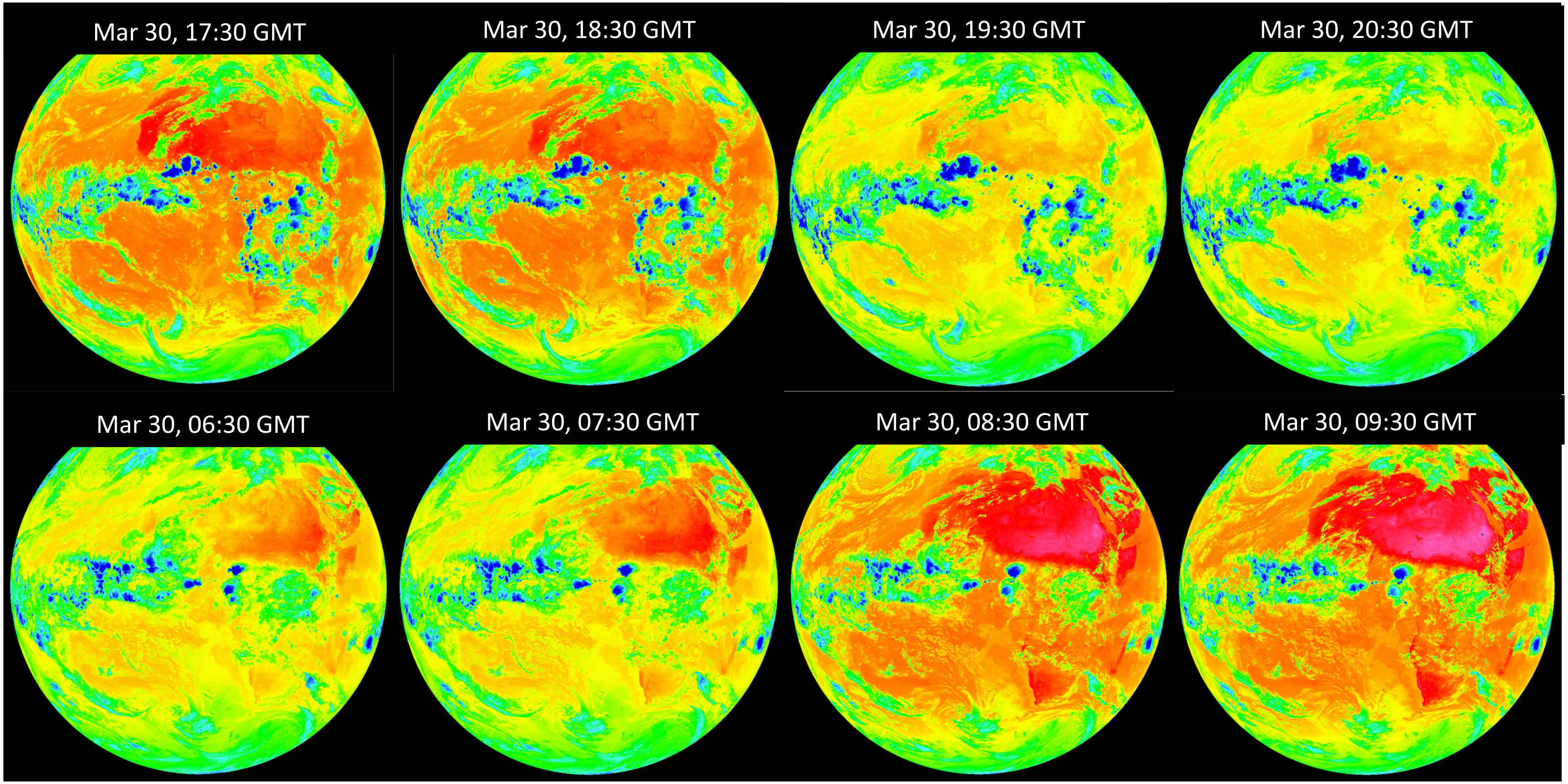


- The 20:33 GMT image navigation is off by 90-km
- Navigation errors can be spotted by a white ring at the bottom of the Earth, where Earth data is expected but space is viewed



Calibration drifts

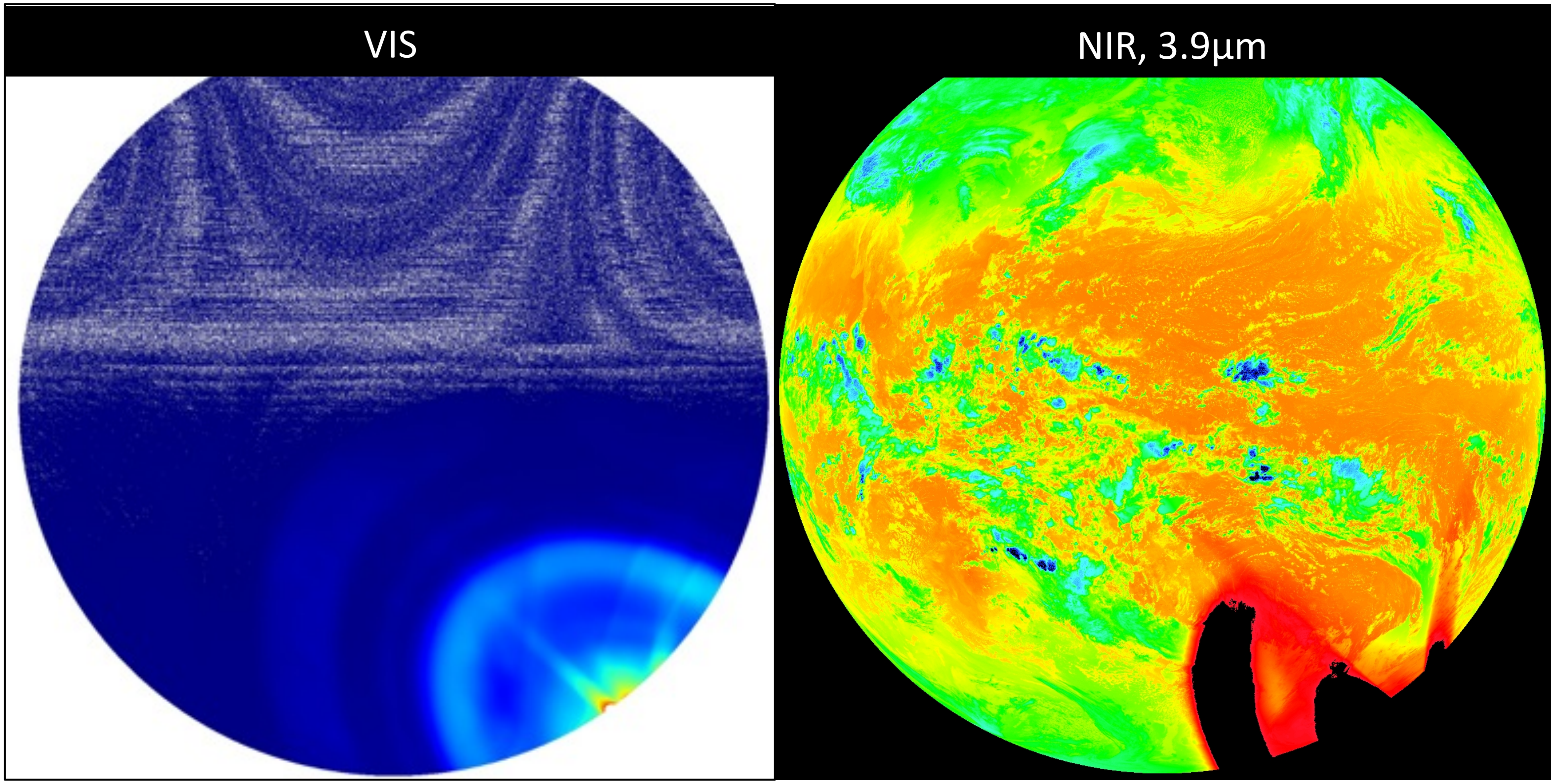
Met-7 11 µm, March 30-31, 2000



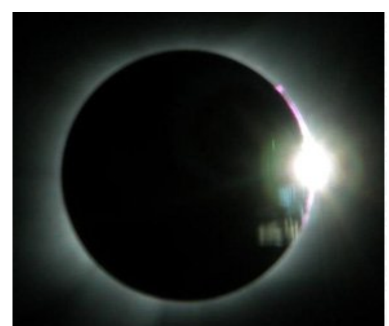
A dramatic cooling of the ocean temperatures, beginning at Mar. 30 19:30 GMT and ending in Mar. 30, 8:30 GMT

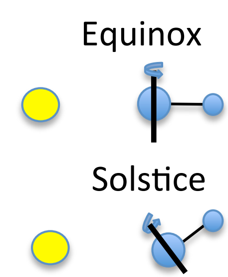
Stray Light

MTSAT-2, Feb. 28, 2012, 14:30 GMT



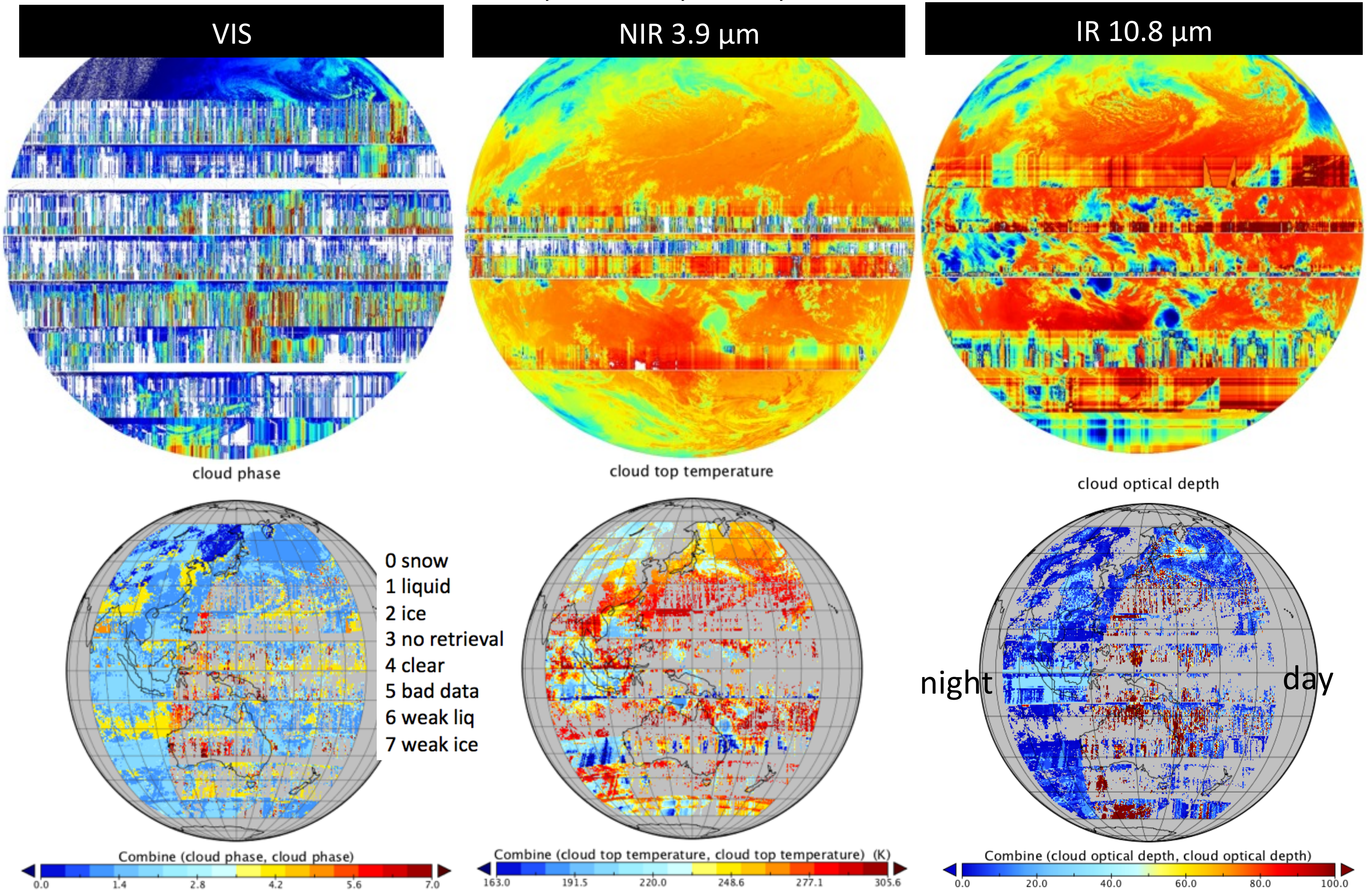
- During eclipse season 14:30 GMT is effected, stray light appears and may effect IR channels,
- GOES has an algorithm that removes the stray light effects from the IR images at night
- Other GEOs simply do not scan to avoid blinding the sensors by the sun



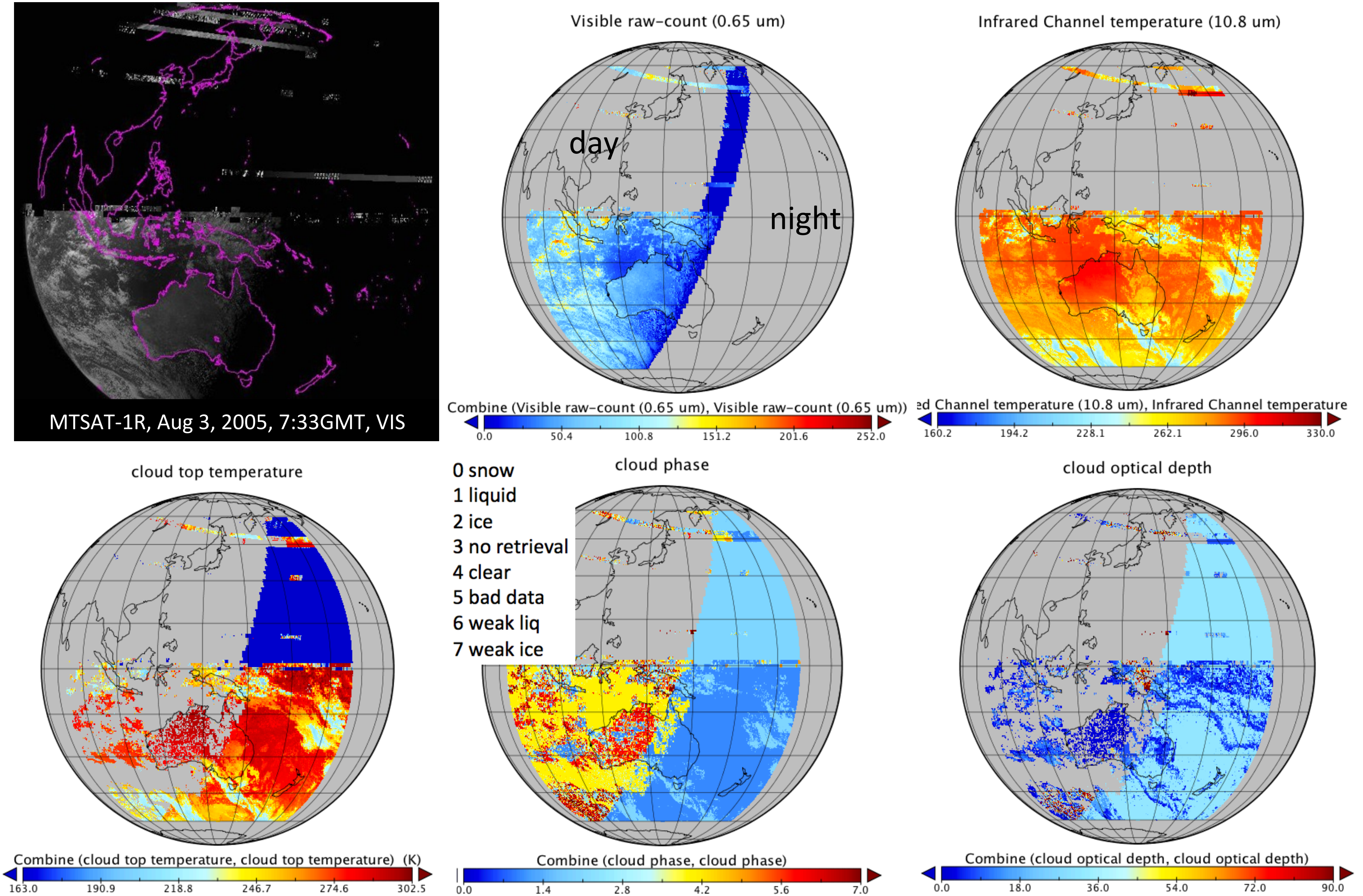


Vertical Striping

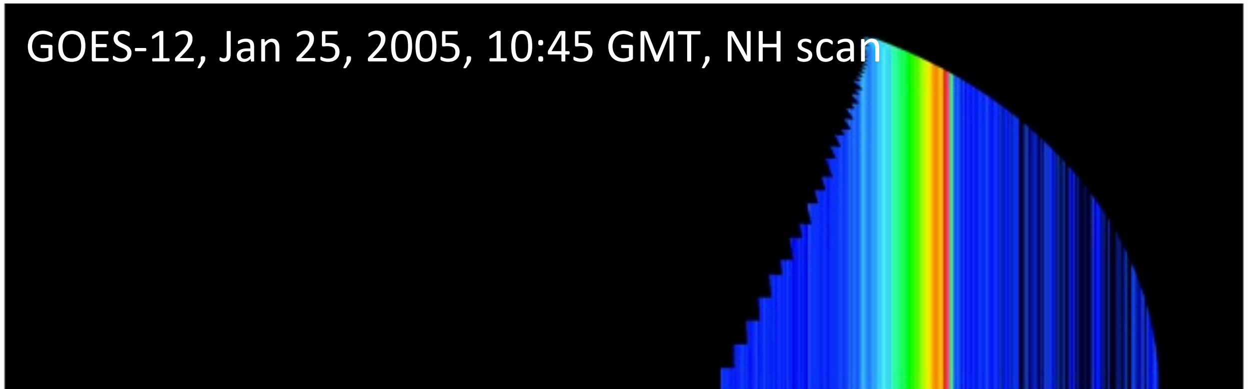
MTSAT-2, Feb. 18, 2015, 22:32 GMT

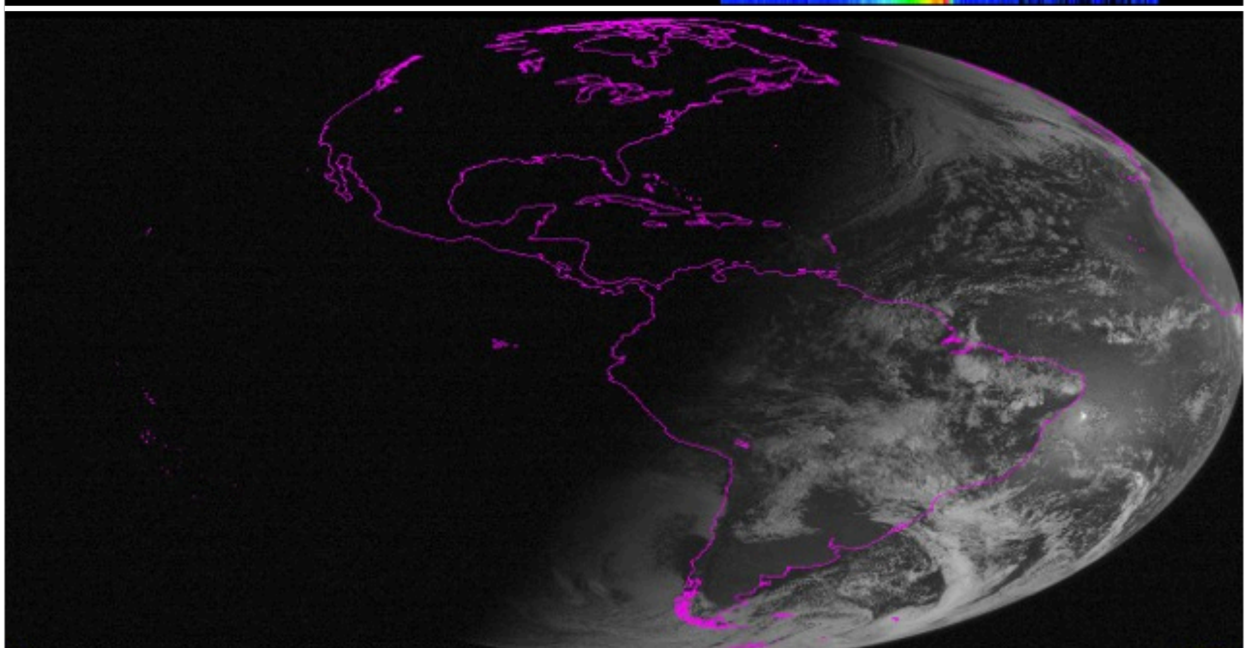


It would seem there would be no retrieved cloud properties in the northern hemisphere, very cold IR temperatures were observed (130K), outside the valid range



GEO processing artifacts





- The McIDAS data was good, however, either through downloading or processing of GEO retrievals the data was corrupted when the netCDF file was written out.
- This GOES-12 image was downloaded again and no corrupt data was seen.
- Data gaps during downloading and data corruption must also be identified to successfuly process the GEO data.

March 2000 image quality summary

March 2000	Satellite	Possible Hours	Actual Hours	McIDAS Missing	Hours with bad data	% Bad
75° W	GOES-08	744	672	9.6%	148	22%
135° W	GOES-10	744	675	9.3%	164	24%
0° E	MET7	744	680	8.6%	62	9.1%
140° E	GMS5	744	617	18%	71	9.5%
60° E	MET5	744	686	7.7%	44	6.4%

• Most of the McIDAS database missing hours are due to eclipse solar avoidance
• For GOES one third of the are half scan lines, whereas two thirds are full scan line spurious issues, not black scan lines

January 2005 image quality summary

Region Jan 2005	Satellite	Possible Hours	Actual Hours	McIDAS missing	Hours with bad data	% Bad
75° W	GOES-10	744	740	<1%	Under analysis	
135° W	GOES-12	744	743	<1%	2	<1%
0° E	MET8	744	694	6.7%	10	1.4%
140° E	GOES-09	744	742	<1%	Under analysis	
60° E	MET5	744	741	<1%	61	8.2%

- Only Met-8 had missing McIDAS data,
  - Instrument IR channel deicing event, Jan 11 and 12, 2005
  - Lost due to interference at SSEC associated with inclement weather, Jan 22, 2005
- Note how GOES instruments image quality is improving over time
- Met-8 is the 2nd generation, whereas Met-5 and Met-7 are 1st generation, image quality is improving over time

- GEO processing priority is 2005 to 2010 during the ARGO period for EBAF

GEO spurious data mask success rate

GMS-5 and Met-5 evaluated for March 2000

GMS-5 Initial	Detected	Missed
Human	68	3
Mask	51	20

Met-5 Initial	Detected	Missed
Human	74	462
Mask	528	8

GMS-5 Current	Detected	Missed
Human	68	26
Mask	87	7

Met-5 Current	Detected	Missed
Human	71	13
Mask	71	13

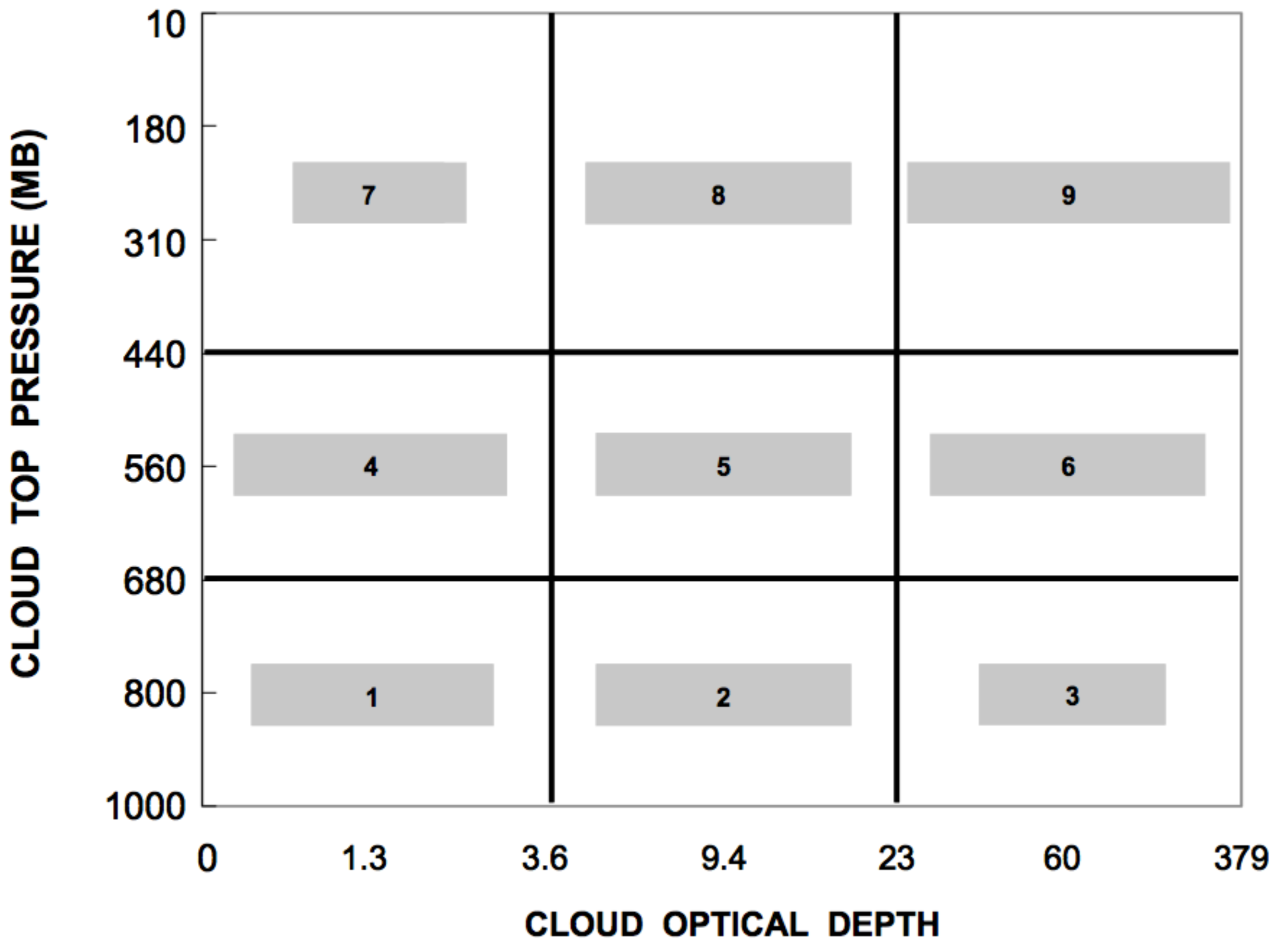
- Konstantin's spurious data detection mask can be tuned to match results of human visualization, Here two satellite were either over- or under-predicting spurious images
- For Met-5 the mask has missed some IR channel banding images
- For Met-5 the mask outperforms human detection of bad scan lines
- For GMS-5 the mask has missed navigation errors and 1 banding image
- For GMS-5 the mask caught near pole issues, not necessary for CERES GEO processing

- A 6-month effort once the mask has been optimized for all the satellites.

CldTypHist Ed4 product

- Monthly 1-hourly product
  - Takes advantage of the 1-hourly GEO cloud retrievals
  - Monthly 1-hourly cloud properties formatted by cloud pressure and optical depth
- ISCCP-D2 name no longer confusing to user
  - No longer in ISCCP-D2 format, but similar
- Only one CldTypHist product that merges Terra, Aqua and GEO 4-channel and 2-channel cloud retrievals
- The CldTypHst product hourly binning MODIS and GEO data is similar to the SYN1deg product
  - This allows the CldTypHist monthly mean cloud properties to be directly compared with the SYN1deg for validation
  - For the CldTypHist product, data gaps are not temporally interpolated as they are for the SYN1deg product

CldTypHist cloud classification



- Same as the ISCCP cloud classification

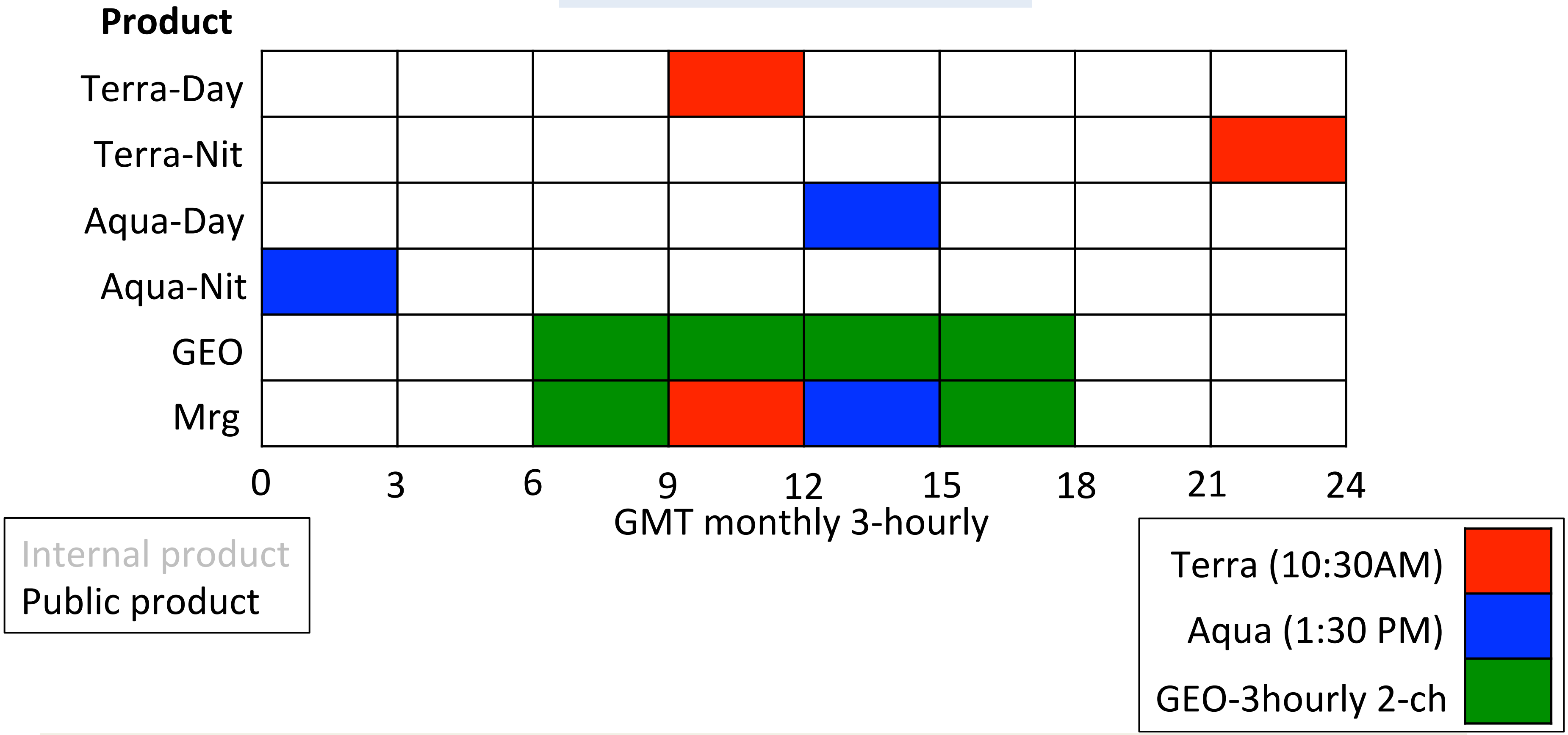
CldTypHist cloud properties

Parameter	MODIS Day/night	GEO 4-ch Day/night	GEO 2-ch day	GEO 2-ch night
Cloud fraction	X	X	X	X
Effective Pressure	X	X	X	X
Effective Temperature	X	X	X	X
Effective Height	X	X		
Top Pressure	X	X		
Top Temperature	X	X		
Top Height	X	X		
Optical Depth	X	X	X	
LWP/IWP	X	X		
Ice/Liq Particle Size	X	X		
Cloud Emissivity	X	X		

X Same as Edition 3
X New for Edition 4

ISCCP-D2like Ed3 products

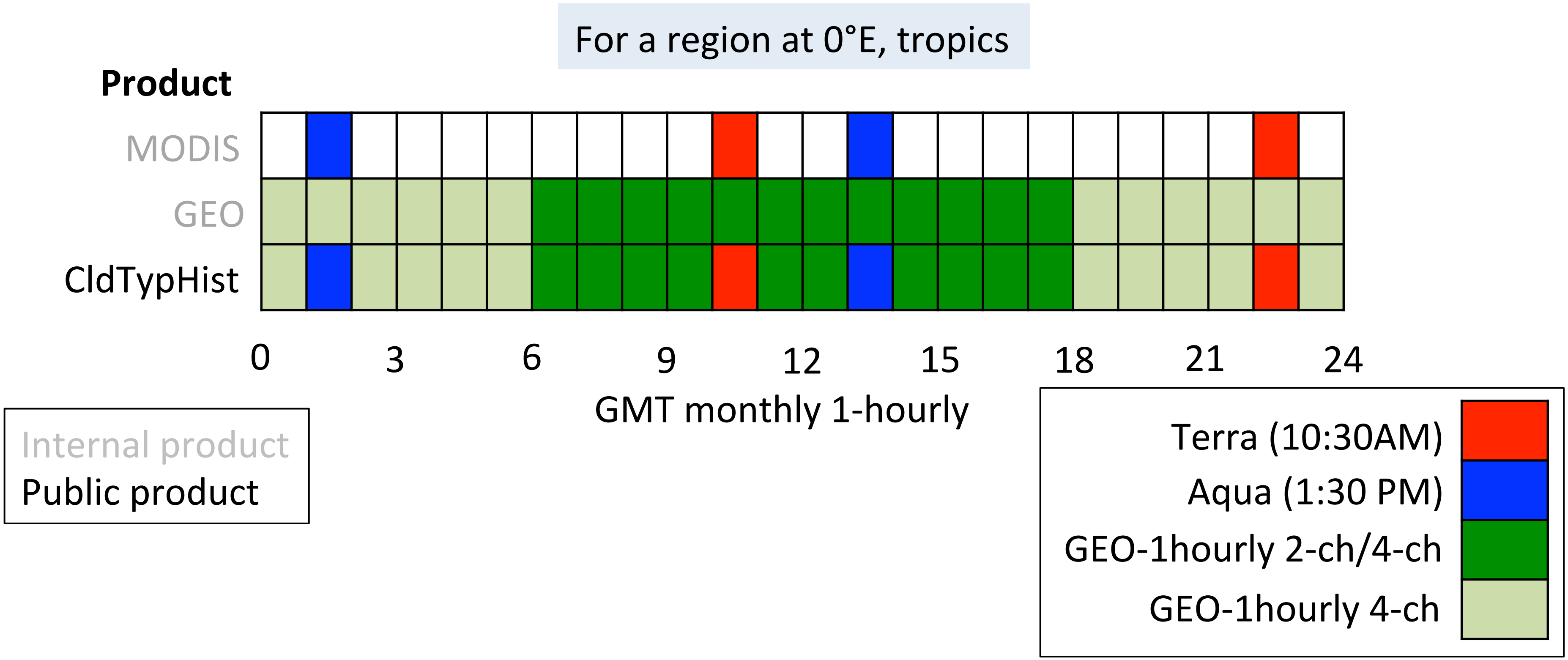
For a region at 0°E, tropics



• GEO 2-channel clouds retrieved for 3 pressure layers, to bin by optical depth a gamma distribution, based on linear and log averaged optical depth, is assumed.

• For the Mrg product the GEO clouds are normalized with MODIS. The early morning bin is normalized with Terra, the late afternoon with Aqua

CldTypHist Ed4 products



- 4-channel GEO pixel-level cloud code does not require the use of the gamma function to distribute pressure layer optical depth into optical depth bins as does the 2-channel GEO layer-level cloud code, no 2-channel GEO clouds available at night.
- MODIS cloud properties take precedence over GEO. Number of MODIS and GEO measurements available at the monthly hourly temporal resolution. The Terra and Aqua-MODIS cloud properties should be very similar for Edition 4

Validation of CldTypHist and SYN1deg

CldTypHist processing

SSF footprint level

GEO pixel level

Grid into 3x3x2 cloud types and region

Monthly hourly cloud types
Merge hourly Terra, Aqua, GEO
No temporal interpolation

Monthly mean cloud types and total cloud

SYN1deg processing

SSF footprint level

GEO pixel level

SSF1deg-hour
4 layer and region

GGEO gridded
4 layer and region

TSI, merge hourly Terra, Aqua, GEO
Temporally interpolate data gaps

SYN1deg, monthly means

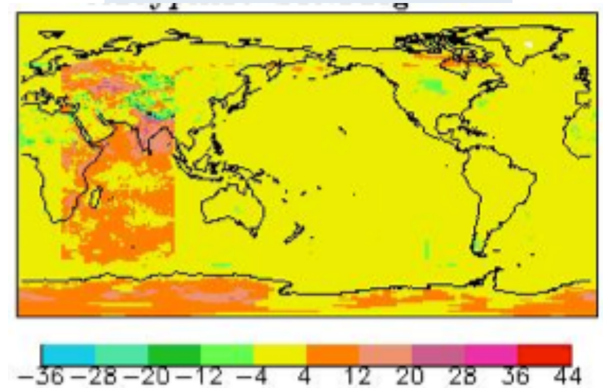
CldTypHist monthly means~SYN1deg monthly means

Comparison of CldTypHist and SYN1deg monthly means

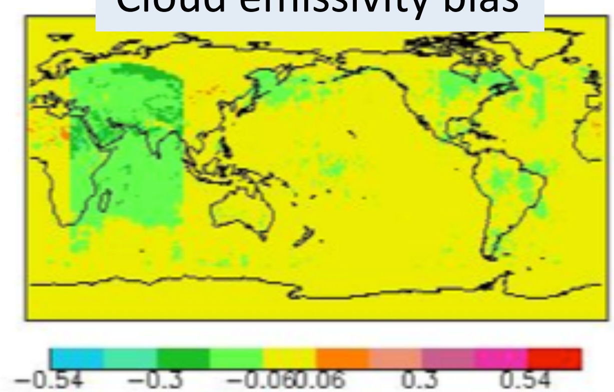
Parameter	mean	Bias (%)	RMS (%)
Cloud amount	65.6	1.2	5.8
Eff temperature	255.2	-0.3	0.7
Eff pressure	630	-0.1	2.1
Eff height	4.35	3.4	5.2
Liq particle size	11.5	-0.5	3.4
Ice particle size	27.4	-0.7	2.8
emissivity	0.818	-2.4	5.9
LWP	84.4	7.7	24
IWP	134	11	23
Optical depth	4.44	-19	58

- Most of the biases occur over the temporally interpolated cloud property Indian Ocean domain, where some cloud properties at night are not retrieved and assume an emissivity of unity
- Sill looking into LWP/IWP and optical depth

Cloud amount bias



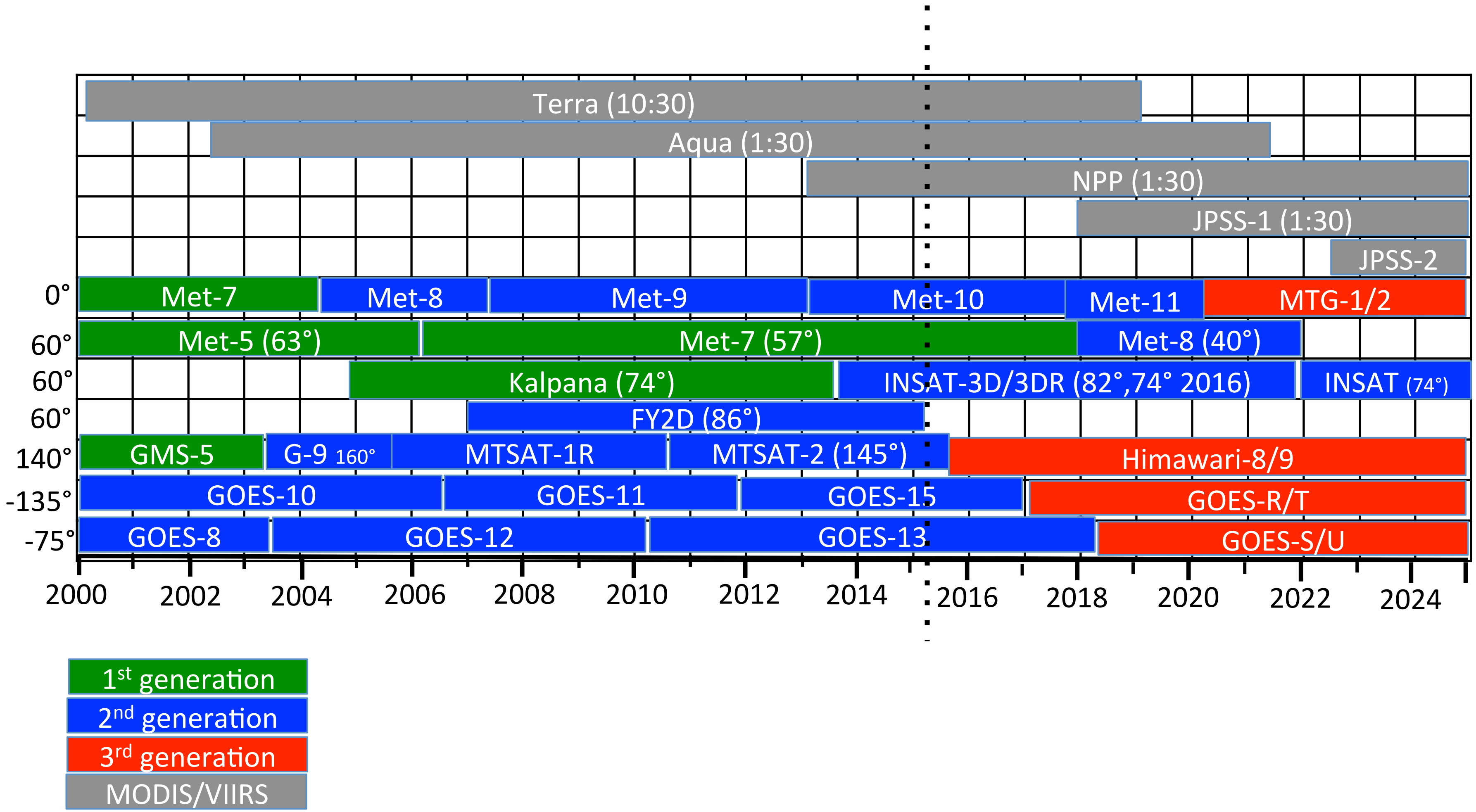
Cloud emissivity bias



TISA Edition 4 delivered products
from the last CERES Science Team Meeting

- SSF1deg stream, SSF1deg-1hour, SSF1deg-day/month codes
  - This allows SSF->SSF1deg-1hour->SSF1deg-day/month to be processed together in monthly time steps
  - One product for each CERES satellite, Terra, Aqua, and NPP
  - SSF1deg-hour HDF is new, now able to visualize hourly gridded data, similar to SSF
- SYN1deg stream, TSI, SYN1deg codes
  - GGEO monthly gridded files are processed off-One product that includes, Terra, Aqua, and GEO
  - SYN1deg now has 1-hourly, 3-hour, daily, as well as monthly
- Validated parameters over many time and space scales using the subsetter extensively
  - Ed4 compared to Ed3
  - Inter-compared SYN1deg, SSF1deg, SYN1deg-lite, and SSF1deg-lite, the lite products are used to generate EBAF input, two paths same answer approach
  - Issues were found in both Ed4 and Ed3 codes
- Removed at P6 and x86 platform differences
  - Differences in precision discovered of intrinsic functions
- Major challenges
  - Convert all codes to GMT time, each region and hourbox has a unique integrated SZA
  - Incorporate hourly GEO cloud properties, with twice as many paramaters
  - Edition 4 has ~ 2x the parameters as Ed3, scalability is a major issue, process as single regions over all observations for the month, read and output data as global maps

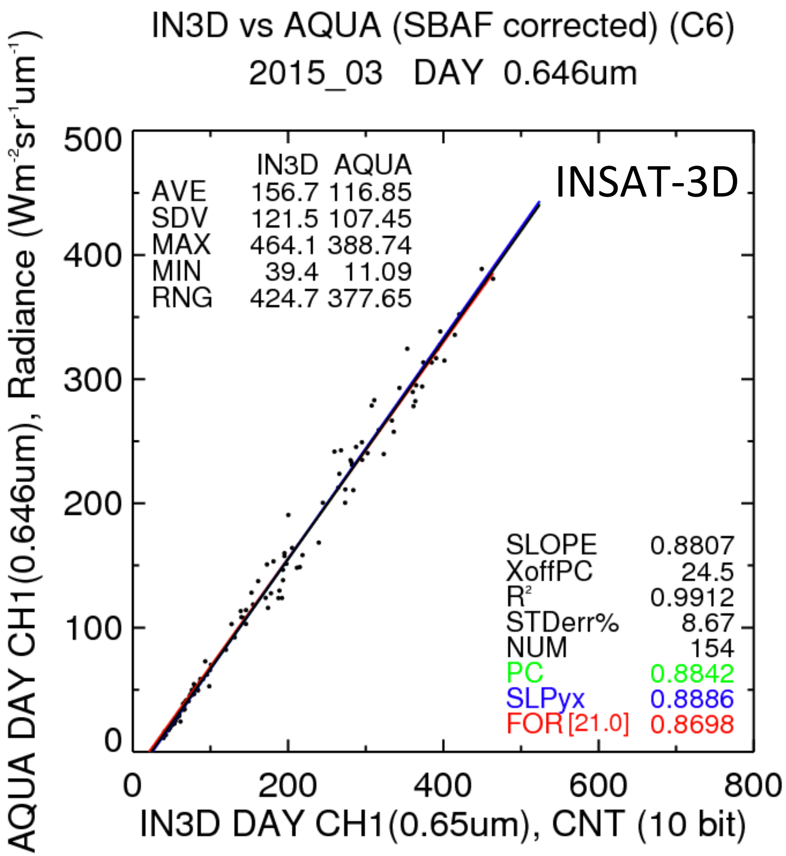
MODIS, VIIRS and GEO satellite timeline

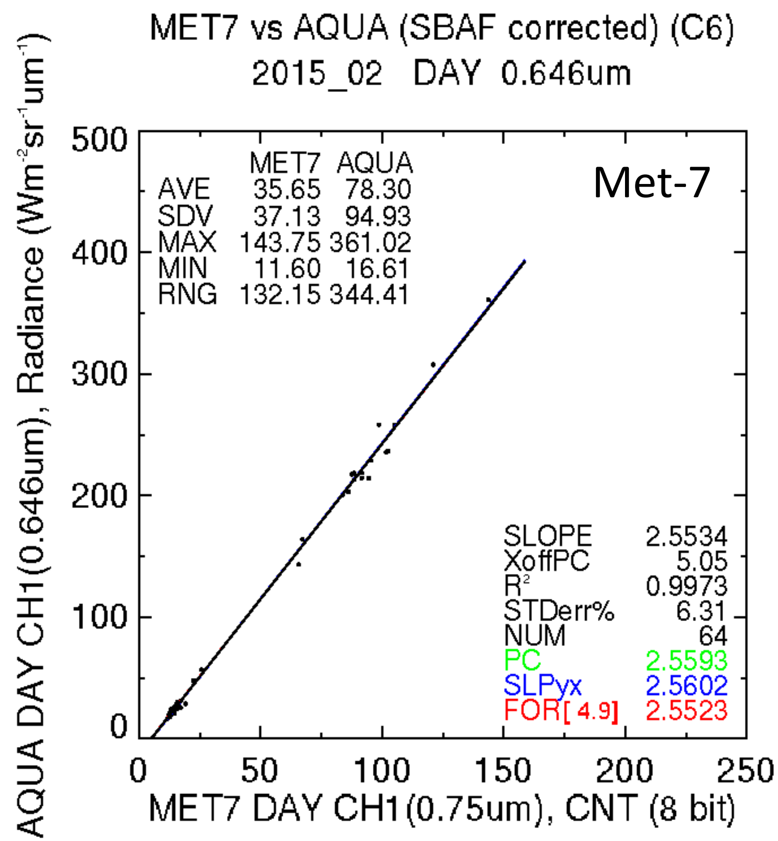


INSAT-3D

- Launched July 25, 2013 at 82° East
  - Operational from Jan 16, 2014 till 2021
  - Second INSAT-3DR to be launched in 2015 at 74° East with same imager as INSAT-3D
- First Indian 2nd generation imager satellite
  - 0.65µm, 1.6µm, 3.9µm, 6.8µm, 10.8µm, 12µm
- Data made available on McIDAS April 28, 2015
  - Collaborative effort between IMD, ISRO, McIDAS and CERES
  - McIDAS obtaining the entire record, June 2014 to present
- Test imager calibration and sensor linearity against Aqua-MODIS

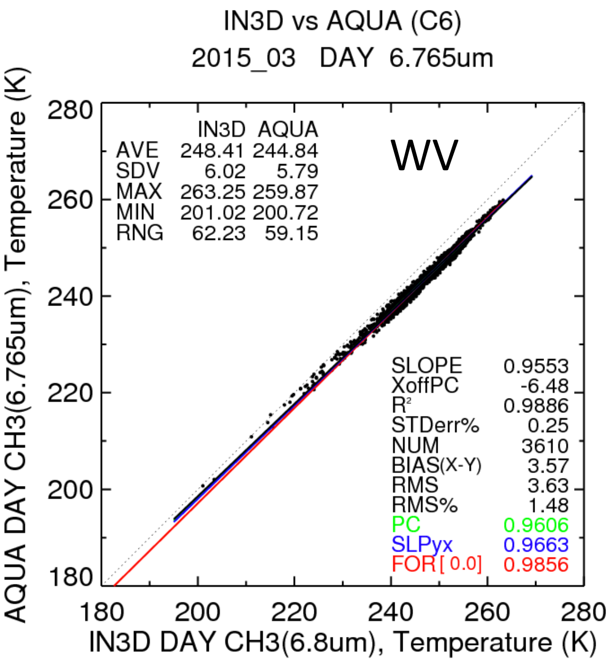
INSAT-3D 0.65µm channel

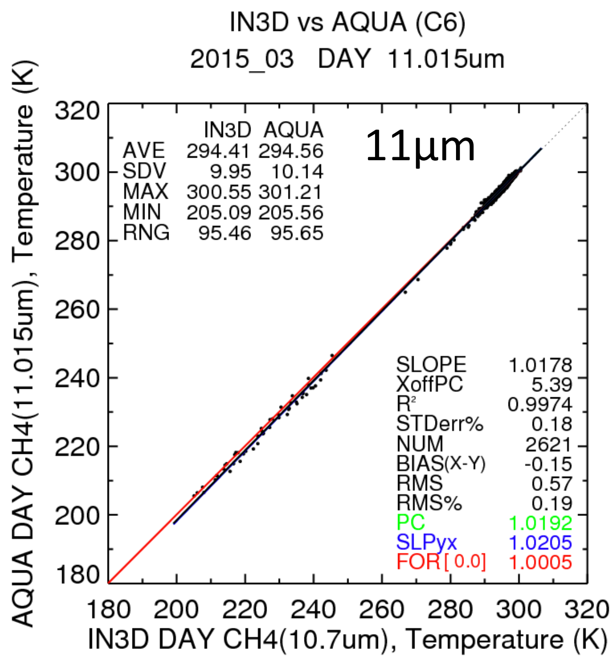


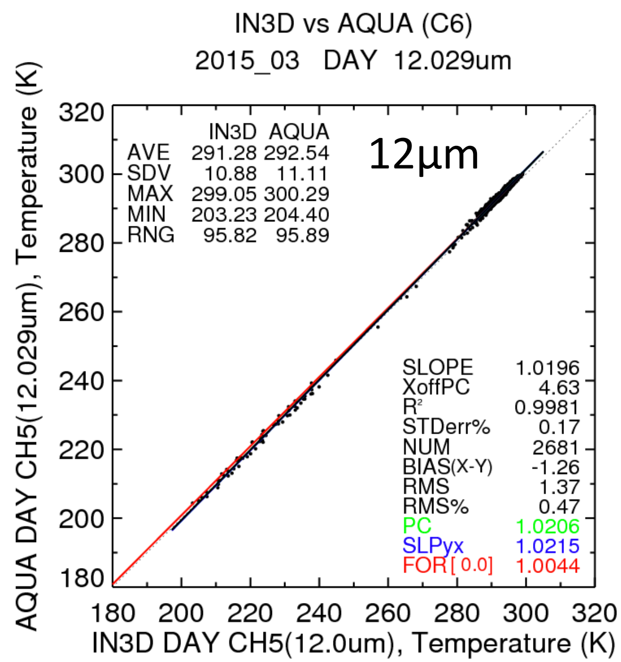


- Only one month available at McIDAS
- The visible sensor is linear with respect to Aqua-MODIS band 1
- Space count is the average count at night over the visible image

INSAT-3D IR channels







- IR channels are well calibrated
- No spectral response differences removed

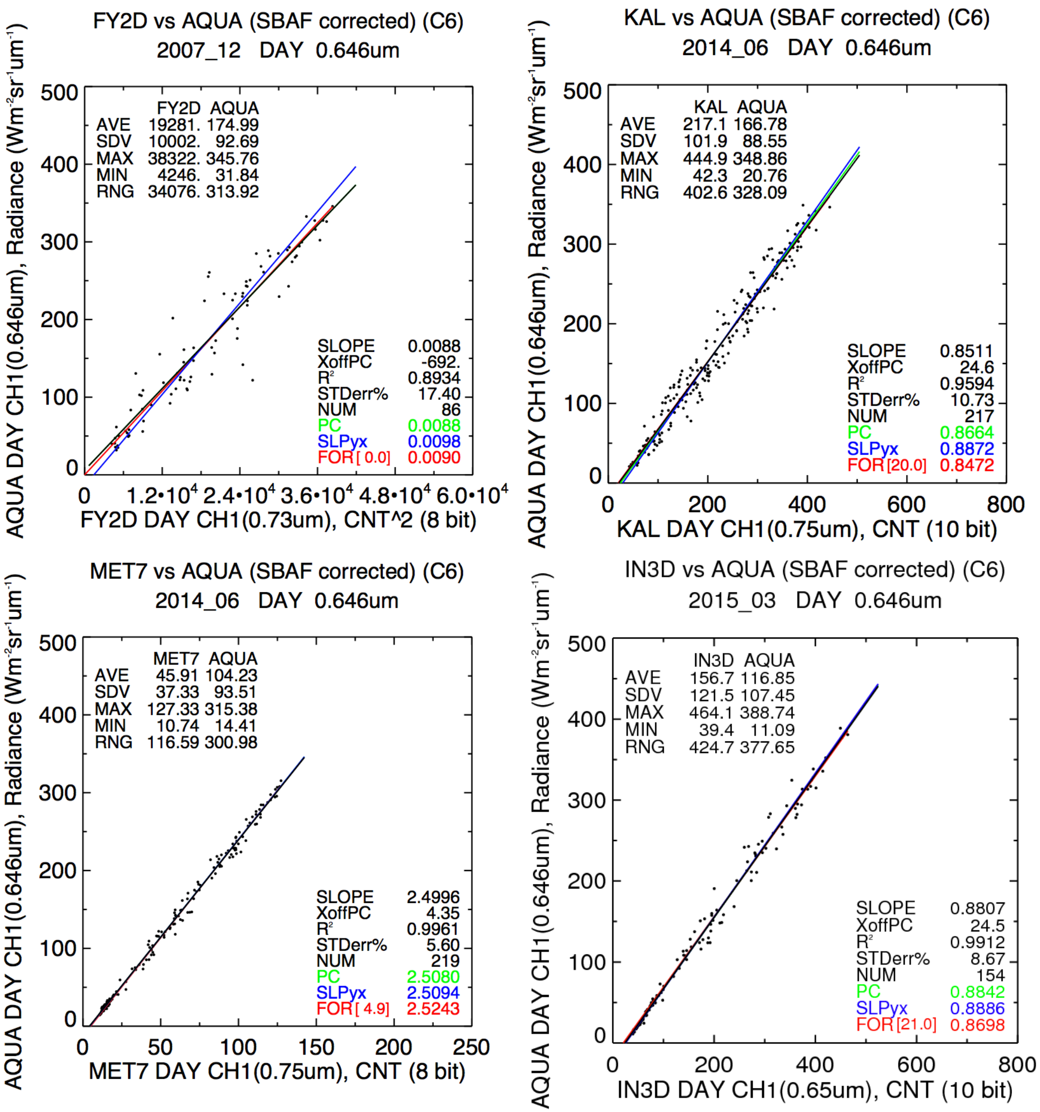
- Process INSAT-3D data from June 2014 to present for Edition 4

FY2D/Kalpana/Met-7

- The Chinese FY2D satellite (86°E) is the first operational 5-channel GEO over the Indian Ocean, beginning in August 2007
- The Indian Kalpana 3-channel GEO satellite (74°E) has been in operational for nearly 10 years, since December 2004
- The Eumetsat Met-7 3-channel GEO satellite (57°E) has been in operational for 16 years, since 1998
  - Is in a non-maintained orbit, where the daily figure 8 orbit about the equator now elongates to 10°N/S, usually maintained to be within ±0.1°

FY2D/Kalpana/Met-7/INSAT-3D

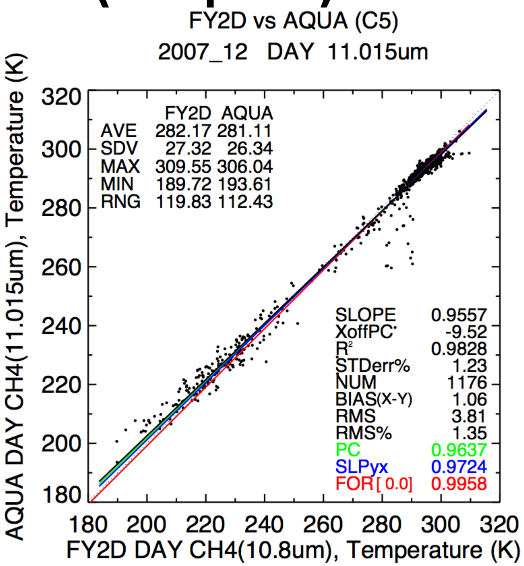
visible channel calibration with Aqua-MODIS

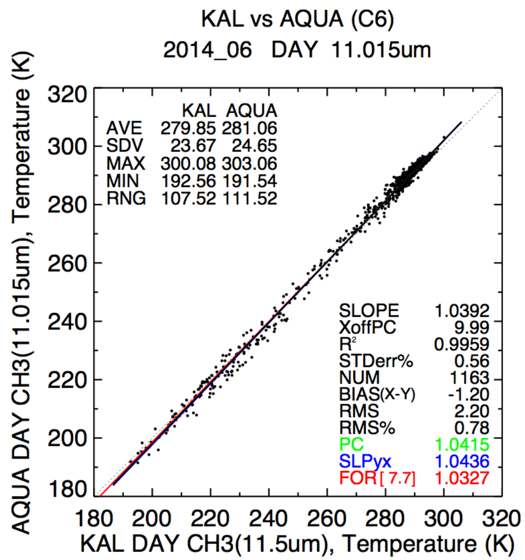


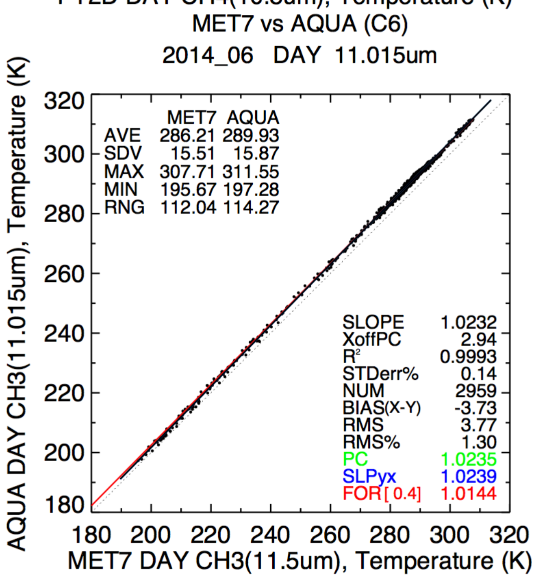
- Good news that INSAT-3D visible image quality and calibration is similar to Met-7
- FY2D satellite visible image quality is far to noisy for 5-channel cloud retrievals
- Kalpana visible image quality is inferior to Met-7 but has linear sensitivity

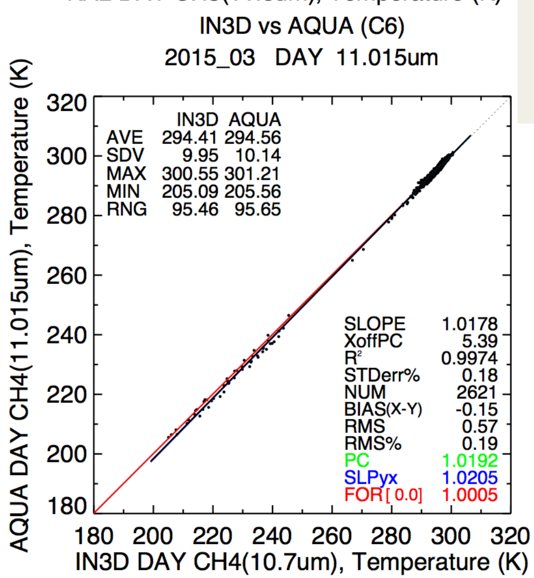
FY2D/Kalpana/Met-7/INSAT-3D

IR (11µm) channel calibration with Aqua-MODIS









- Good news that INSAT-3D IR image quality and calibration is similar to Met-7
- FY2D satellite IR image quality is far to noisy for 5-channel cloud retrievals
- Kalpana visible image quality is inferior to Met-7 but has linear sensitivity

- Continue to process Met-5 and Met-7 over the Indian Ocean region from March 2000 to May 2014 when INSAT-3D begins

VIIRS, MODIS and GEO bands

	VIIRS				MODIS		GEO						
µm	Band	SSF Day	SSF Night	cloud	SSF Day	SSF Night	Hima wari	GOES ABI	MTG	MSG	Insat 3D	2nd	1st
0.49	M3	F			F		X	X	X				
0.56	M4	P			P		X		X				
0.67	M5												
0.64	I1	F		X	F		X	X	X	X	X	X	X
0.87	M7	F			F		X	X	X	X			
0.87	I2												
1.24	M8	P		X	P								
1.38	M9							X	X				
1.61	M10												
1.61	I3	P		X	PT		X	X	X	X	X		
2.25	M11	P			PA		X	X	X				
3.7	M12	P											
3.74	I4		F	X	P	P	X	X	X	X	X	X	
8.55	M14	P	F	X	P		X	X	X	X			
10.8	M15	F	F	X	F		X	X	X	X	X	X	X
11.5	I5		F										
12.0	M16	F	F	X	F		X	X	X	X	X	X	
6.7	WV				P	F	X	X	X	X	X	X	X

F=CERES footprint, total, clear and layers
P=CERES footprint, total and clear

Future TISA efforts

- Convert the GEO calibration to the VIIRS reference and monitor stability of VIIRS
- Process 15 years of GEO cloud properties and QC
- Improve SW NB to BB with Himawari-8 spectral measurements, and cloud properties
  - based on MODIS NB to BB coefficients
- Deliver the CldTypHist Ed4
- FluxByCloudTyp Beta product
  - Instantaneous gridded CERES fluxes by cloud type as in CldTypHist, based on CERES sub-footprint MODIS derived broadband fluxes
  - Working on a CERES simulator, similar to the ISCCP simulator
  - Make product available for beta users before releasing simulator (Fall 2015) and get user feedback
- Validate the TISA Edition 4 products and write DQS
  - Use GERB and ScaRaB to validate diurnal fluxes
- Begin to look at TISA code to make it more robust for future algorithms and scalability, and future GEOs